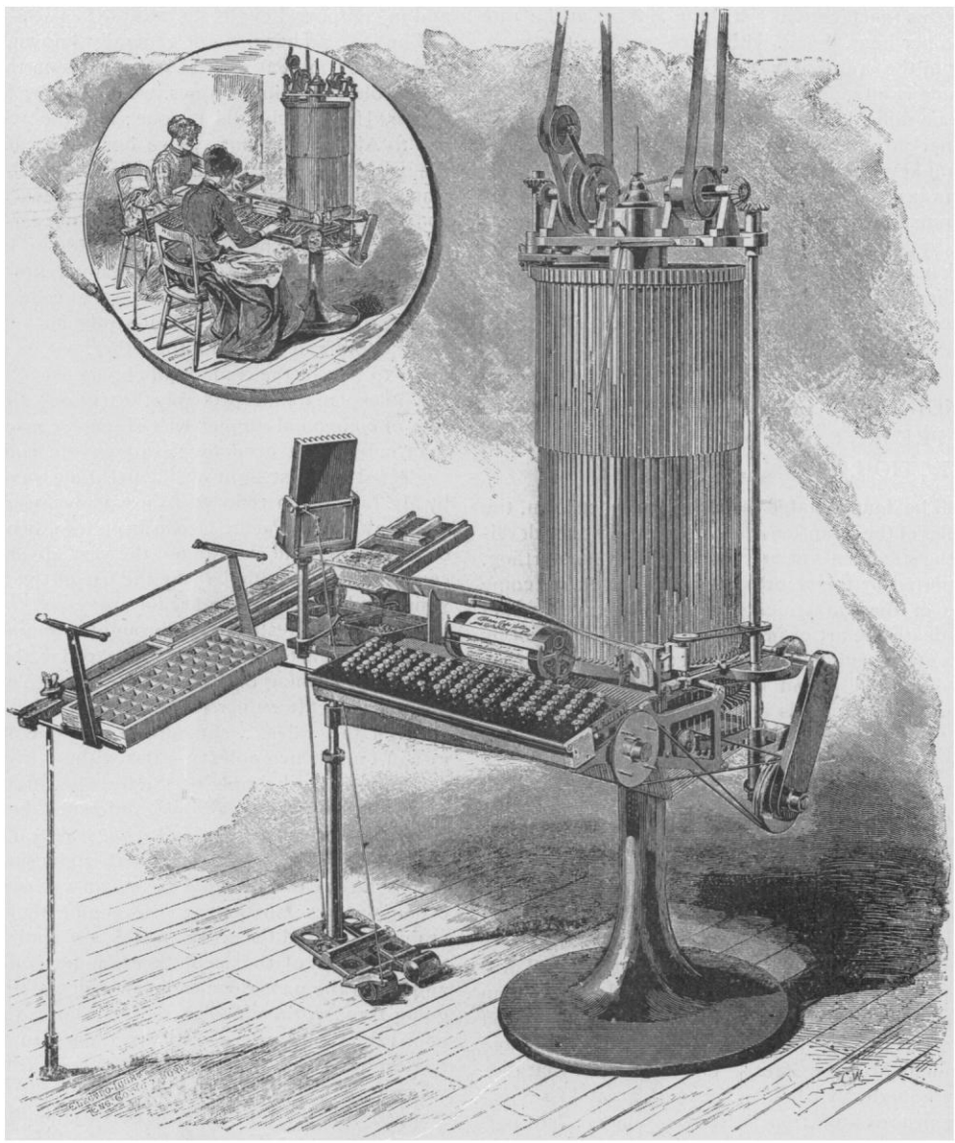
SCIENCE

FRIDAY, FEBRUARY 8, 1889.

THE THORNE TYPE-SETTING MACHINE.

IT is nearly ten years since Mr. Joseph Thorne invented the type-setting machine bearing his name. This machine, as now manufactured by the Thorne Machine Company of Hartford, Conn., modified by the improvements suggested during several years' actual use in type setting and distributing, is shown in the accompanying engraving. This machine is now doing good service in book and newspaper offices in this country and Europe. Its working, as seen by a representative of *Science* a few days ago in an office in this city, where several of them have been in use some years, leaves little to be desired in the way of rapid and accurate distribution and composition.



THE THORNE TYPE SETTING AND DISTRIBUTING MACHINE.

The machine consists of two iron cylinders, mounted vertically one above the other upon the same axis. The upper one of these two is the distributing-cylinder, and the lower one the setting-cylinder. The types, before distribution, are arranged in vertical channels in the upper cylinder, where they rest upon their sides. The distributing-cylinder revolves with an intermittent motion, thereby causing its channels at each step to coincide with and rest directly over similar channels in the setting-cylinder, which remains stationary.

Ordinary fonts of type are used, but each character has distinctively arranged notches, with which correspond wards at the upper end of each channel in the setting-cylinder; so that a type of a given character can only fall into its own proper groove in the latter. In these grooves the types rest on a bottom plate. The types in the distributing-cylinder are in the order they come from the forms; but by the step-like motion of the cylinder, and the action of the wards in the channels of the setting-cylinder, the types are automatically sorted, so that each channel of the stationary cylinder contains only types of the same kind.

Composing is effected from a keyboard like that of a type-writer, on a somewhat larger scale. By the depression of any key, through

an arrangement of levers and rods, the lowest type in the corresponding groove of the composing-cylinder is pushed radially outwards on to a very rapidly revolving disk, which carries it to an opening in the stationary guard surrounding the disk, and delivers it upon a moving belt, on which the types are carried in their proper order to a revolving lifter, which raises them in succession into a long setting-stick in front of the operator, terminating in a justifying-stick at the upper end of an inclined channel or galley.

In justifying, a section of the composed line of type is drawn to the mouth of the justifying-stick, and is justified with spaces taken from a case containing channels for the different spaces and the hyphen, the lowest of which are pushed partially out by ejectors worked with a treadle.

The lines of type, when ready for distribution, are inserted in the grooves of the distributing-cylinder from a special galley by means of a slide, with which a whole line at a time is pushed bodily into a groove.

It is claimed that this machine will distribute and set at the rate of six thousand ems per hour, doing, with three persons, the work of six men working in the ordinary way. Considering the purpose for which the machine is intended, the construction is simple, and there appears to be no difficulty or hitch in the working.

It should be remarked, that, by manipulating the keys in one direction only, several keys may be touched simultaneously without risk of the characters becoming transposed. In working the opposite way, each key must be touched separately. The machine is driven from a shaft by two small belts. One belt transmits motion to the revolving disk below the type-setting cylinder and to the type-lifter; while the other belt, by means of a tightening-pulley and ratchet-gear, produces the step-by-step motion of the distributing-cylinder.

THE STEAM-ENGINE, ITS PRINCIPLES, ITS DEVELOPMENT, ITS PRESENT CONDITION, AND ITS FUTURE PERFECTION.[1]

IN this lecture will be found, stated in a very compact form, the fundamental principles of the steam-engine, and a history of its development. Some of the statements at first glance seem very startling, but they are so supported by the records that surprise is overcome by conviction. One of these statements is, that "for a generation after James Watt's death the art of producing power from fuel by the intervention of a steam-engine retrograded; so that less power was usually obtained from a pound of coal consumed than had been obtained by the use of methods invented and fully explained by James Watt."

This is illustrated by the following: "Founded upon these principles, the steam-engines which were made by Mr. Watt and his associates and pupils before 1830, produced a horse-power with less than two pounds of coal an hour. These engines are known as the Cornish pumping-engines; and, if you will look into the history of these machines, you will find them reported as doing more than a 'hundred millions of duty,' which is a technical phrase, intended to express the fact that a hundred million pounds of water were lifted a foot high for a hundredweight of coal consumed. Turning that into horse-power, it means about two pounds of coal an hour a horse-power. This result was produced by cutting off steam in the cylinders at one-sixth or one-eighth of the stroke, and allowing it to expand six or eight times. The engines of that day, of course, were very imperfectly constructed, and great losses occurred from leaking pistons and from defective boilers; but, notwithstanding that loss, the result was equal to two pounds of coal an hour a horse-power."

In a note on the subject, reference is made to the authorities showing the "duty" of Cornish engines before 1830 to be more than a "hundred millions," or, what is the same thing, a horse-power with less than two pounds of coal an hour. Perhaps the contrast between the engines did not attract much attention, because the Cornish engine's economy was always stated in terms of weight lifted, whereas economy in other engines was stated in terms of coal an hour a horse-power.

[1] Abstract of a lecture delivered by Edward N. Dickerson, LL.D., before the Electric Club of New York, Jan. 17, 1889.

The lecturer, on this subject, makes this statement: "When steamships came to be built in England in 1840, and afterwards, notwithstanding the fact that high expansion with great economy was in constant operation on James Watt's Cornish engines and on Wolff's compound engines, no attempt was made to work the marine engines under high expansion; and as a consequence all the earlier steamships, for more than thirty years, were running at a cost of at least four pounds of coal an hour a horse-power; while, at the same time, compound engines had been well known for a generation, and were in actual use, making a horse-power for about two pounds of coal an hour. The Cunard Company, however, were making money in their business; and they considered that a sufficient answer to any suggestion that their fuel account was enormously expensive."

It is certainly a very remarkable fact that for a generation steamship-owners did not use high expansion on their ship-engines, when it had been in use on shore for thirty years, both in single and in compound engines.

The fact, perhaps, is not generally known, as stated by the lecturer, that "in 1825 several steamboats on the North River worked by double expansion engines, were built by Mr. Allaire in this city, — the 'Henry Eckford' for one; and the 'Sun,' which made the trip to Albany in about twelve hours, for another. At that time the subject was not well enough understood, and economy in fuel was not considered of so much consequence as the first cost of construction, and these engines were not largely reproduced. One of these double expansion engines made in England was brought to this country in 1830, and for many years was used in the oil-factory of Judd's Sons, giving very economical results. When they needed more power, a half-stroke cut-off engine was made for that factory and added to the other, but its results were vastly inferior to that of the compound engine."

The explanation is probably the true one, that the greater original cost of compound engines was of more consequence in those days than subsequent economy; and so the compound engines were neglected and lost sight of, till attention was again called to them by Mr. Jameson in 1860, when it was necessary to save a steamship company on the Pacific Ocean from ruin, because of the high cost of fuel there; and he adopted the very obvious remedy of reducing coal-consumption one-half by the use of the old compound engines, which had been disregarded for years.

One very interesting fact brought prominently forward is thus stated: "The astonishing fact exists to-day, that, on an average, every steamboat running on the waters of New York is wasting certainly not less than fifteen per cent of all the fuel consumed, by leaking through the valves; and almost any one of them will run at the rate of four or five miles an hour without ever opening the steam-valves at all, and simply by the leakage through those valves; and yet that leakage is only the difference between what leaks in through the steam-valves and what leaks out through the exhaust-valves. Some of these steamboat-engines are so constructed that the engineer can 'unhook' the steam-valves without unhooking the exhaust-valves; so that, as the engine moves, the exhaust-valves are working, and the steam-valves are shut. That is particularly true of some of the steamboat-engines on the New Haven line; and when the pilot rings the slow-bell, as he frequently must do in going through the crowded thoroughfares, the engineer simply unhooks the steam-valves and lets them drop shut, and the steamboat moves on at a fair rate of speed from the leakage alone; whereas, if those steam-valves were tight, the engine would be stopped in half a revolution. This tremendous loss is not appreciated, because it is a case of internal hemorrhage, and no visible sign appears. The steam leaks into the condenser, and is pumped overboard with the condensing water; but, as far as I have observed, it has not raised the temperature of Long Island Sound at all, and therefore has not produced any effect on climate; and there is no advantage gained by that tremendous expenditure. The remedy, of course, is very simple, and that is to go back to James Watt, which would mean at least fifteen per cent of saving in the coal-bins."

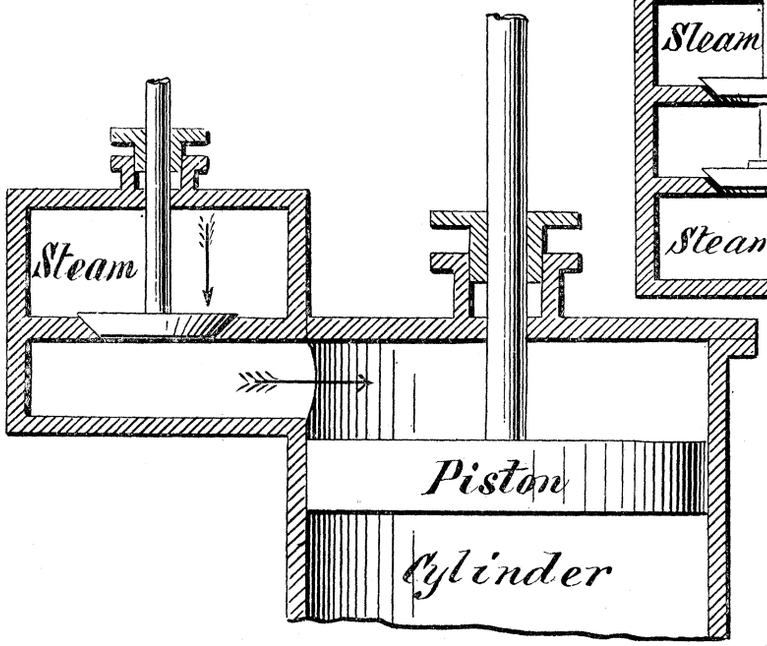
A note very fully explains how this loss occurs, and why it escapes observation. All the earlier steamboats used the single puppet-valves of James Watt, which are necessarily perfectly tight

when once ground into their seats; and, as they are forced into their seats by the pressure of steam, it is impossible for them to leak. But, being heavy to lift by hand, some one invented the double-balanced valve, in which the steam is pressing upward and trying to open the lower of two valves, while it is pressing downward on the upper one; so that there is no trouble in opening them by hand. Of course, such an arrangement must leak; and, when steam once begins to leak, it cuts its way through the crack, and very soon has an open passage.

It has not, however, been supposed that the leak was so enormous as stated; but the lecturer appeals to what he says are facts within his knowledge, and which are easily verified any day. If it is true that steamboat-engines will run the boat without opening the steam-valves, as he says, and that it is done as a practice on some East River steamers when the engine is required to go slow, it is certainly most astonishing that owners should permit such a state of things to continue for a day. As the lecturer says, it is a case of internal hemorrhage, where the patient may bleed to death without knowing the cause.

The lecture contains two cuts, exhibiting the single puppet-valve of Watt, and the double or balanced American valve, as below.

It is very apparent from the sketch that the double valve must be leaky. The pressure upwards on the lower valve



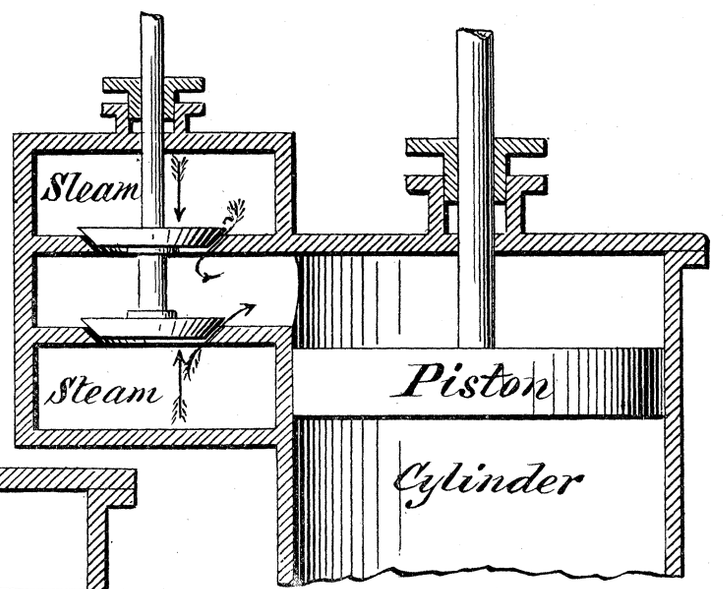
JAMES WATT'S SINGLE PUPPET-VALVE.

balances the pressure downward on the upper one, and of course the valve opens easily; but unless the upper and lower valves, which are rigidly separated by a column, can be fitted at exactly the same distance apart that the seats are, of course they must leak, since no pressure can take effect on either to force it into its seat. If they could be so perfectly constructed as to be steam-tight when cold, the moment they are heated by steam, the expansion of the column must differ from that of the enclosing chest, and at once a leak begins; and when it does begin, it soon cuts away the metal.

The lecturer takes up the present theory that great losses are incurred in working steam expansively, according to the laws of Watt, by what is called "cylinder condensation," which is said to destroy as much as one-quarter of the steam introduced into the cylinder, and to that extent neutralizing the theoretical gain by expansion. This hypothesis was put forward by the engineers of the navy in 1860, as the true explanation of a very common fact, that a steam-engine does not give out power in proportion to the expansion used. This explanation was supported by an experiment tried by the United States on an engine on Lake Erie, to which the lecturer refers as follows: —

"In the history of the development of the steam-engine, one curious phenomenon deserves to be mentioned, and that is the attack upon James Watt and his laws of steam by the Government of the United States during the Rebellion, when vast sums of money were expended in building steam-engines. At that time the Government officially pronounced its judgment of condemnation upon the laws of Watt, and published that judgment in a book, which was distributed to the engine-builders and engineers of the country as the authoritative decision by the United States. This absurd conclusion was reached in consequence of some experiments ignorantly tried by some Government engineers, on a leaky engine on Lake Erie, which, as the report showed, was using more than twice the fuel to the horse-power that James Watt's engines were using. What was proved by the experiment was, that such a machine as that was not a good one to make forty-seven horse-power by expansion; but it was assumed that it proved there was no use in expansion. I quote from that book the following: —

" 'The results obtained from this engine (that is, the Lake Erie engine) are rigorously applicable to all others in which saturated



AMERICAN BALANCED PUPPET-VALVE, WHICH MUST LEAK 15 PER CENT OF STEAM USED BY ENGINE.

steam is employed in a cylinder not jacketed, and show conclusively the utter futility of attempting to realize an economical gain in fuel, under such conditions, by expanding the steam beyond the very moderate limit of one and a half times; and that, if the expansion be carried to three times, a positive loss is incurred; also that if measure of expansion, as high as those due to cutting off the steam at $\frac{1}{6}$ or $\frac{4}{45}$ of the stroke of the piston, are employed, the economy is considerably less than with steam used absolutely without expansion.'

"Upon that principle, the whole steam navy of the United States that was built during the war was constructed. This was a tremendous blow to progress, from which we have not yet entirely recovered; and but for the fact that the engineers of Europe have since built their magnificent steamers, and carried expansion to a high degree, we should have been building a navy to this day in accordance with this ignorance. But James Watt, for a dead man, made a magnificent fight in defence of his principles; and the money and resources of the United States have utterly failed to defeat him."

In an elaborate note, an explanation is made of the way in which this remarkable conclusion was reached, supported by the tabulated report on which it was supposed to rest. As the table shows, the "Michigan's" engine was run at various rates of expansion, beginning at nearly full stroke, and running down to a cut-off at one-eleventh of the stroke, — the pressure of the steam being kept constant, and the revolutions of the engine kept the same, by taking off resistance, — so that at full stroke the engine developed 280

net horse-power, and at one-eleventh of the stroke only 47 horse-power, and in that proportion. Each experiment lasted seventy-two hours. The water was carefully measured as it was taken into the boiler; and the steam which resulted from that water was estimated from the indicator diagrams as it went into the condenser. The result of these trials is thus stated in a note, quoting the figures from the report: —

"In round numbers twelve hundred pounds of water an hour disappeared from the engine, whether the steam followed the piston full stroke, or was cut off at one-eleventh of the stroke; and, of course, the expansion rate had nothing to do with its loss. Indeed, at the high expansion there appeared less loss of water than at lower rates. The fact, of course, was that the double-balanced puppet-valves of that engine leaked about the same amount of steam into the condenser an hour when the engine was running, and it made no particular difference whether the cut-off was long or short.

"If the estimated water in steam, as shown by the indicator, could have been ascertained as accurately as the water pumped in was, it would have appeared that at the high rates a still smaller loss occurred than the tables show, as compared with full stroke; because, after the cut-off valve shuts, the steam-pressure falls off in the cylinder, and less steam ought to leak into the condenser than if the boiler-pressure were kept up in the cylinder during its entire stroke; but these indicator measurements cannot be exactly accurate. They, however, established the fact that in this case high expansion destroyed less steam than full stroke, and so completely demolished the theory which the experiment was tried to establish. That, however, did not prevent the forcing of balances, and other similar manipulation of the honest figures, in order to prove the hypothesis under which the experiment was tried; and the result was announced that the Lake Erie experiment had proved what it was intended to prove, and the official United States Government report was issued to the world, announcing the new discovery.

"If book-keeping could have beaten James Watt, he and his laws would have perished from the earth; but, as it was, they were only driven for a season out of the American Navy."

It is not important for science to know whether the conclusion drawn from the facts was fraudulent, as the lecturer asserts, or simply a stupid blunder. The fact is, that an almost constant quantity, of steam disappeared from the engine in an hour, under all circumstances, and of course its loss had nothing to do with expansion. The quantity — twelve hundred pounds an hour — was a very large percentage of 47 horse-power, and a small percentage of 280 horse-power; and this fact was put forward as proving that expansion destroyed a much larger amount of steam used than full stroke did, whereas in fact a trifle less steam was destroyed when high expansion was used than at any other time.

The explanation, open to any one's verification by the tables themselves, disposes of this extraordinary trial, and destroys the theory based upon it. It is great service to truth to make this exposure.

The lecture ends with this expression of opinion: —

"It is my opinion, that, with our present knowledge of machinery, a steam-engine can be built to day that will produce a horse-power with three-quarters of a pound of coal an hour, if of sufficient size to reduce the percentages of loss by radiation, friction, and leakage, to a minimum. Under those circumstances, your fuel expense would be less than one-third of what it now is."

It would seem that there should be some means of bringing this to a test. No one claims at present less than a pound and a half an hour in the most elaborate and extensive steamers; and, if this opinion is correct, half the coal now used, or a power double that now got from the same fuel in the most perfect machine, would be the result of such an engine.

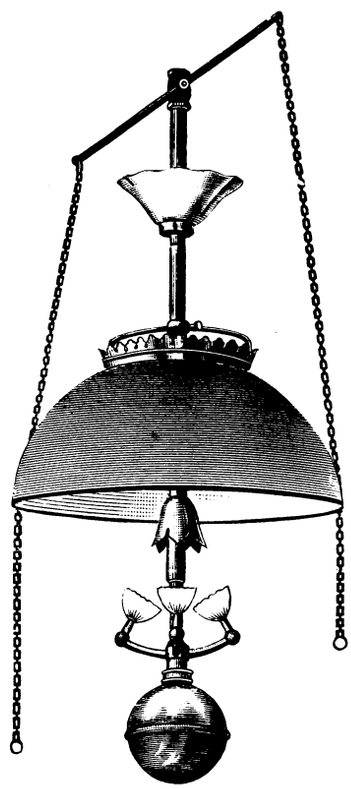
In a review we cannot go over the whole ground on which the lecturer places the case; but to those specially interested in the subject there is matter enough for very serious consideration, and we commend the paper to their notice.

SETH K. WARREN of Geneva Lake, Wis., publishes a little volume devoted to the "Evolution Theory of the Origin of Worlds."

IMPROVED GASLIGHT.

NOTWITHSTANDING the rapid development of the electric-light industry, gas still remains the most widely used and convenient illuminant; and any means of improving the quality or decreasing the cost of gaslight is of interest to the public. One improvement in both these features, now attracting much attention, is known as the "albo-carbon light."

In this light the ordinary illuminating-gas is passed through a simple apparatus, in which it is enriched by taking up a hydrocarbon vaporized by a current of heated gas. It is claimed by the company who have introduced it to the public that one thousand feet of common coal-gas, after being passed through their appliance, will give fully as much illumination as three thousand feet where ordinary burners are used: in other words, the cost of illumination is reduced to at least one-half, while the light is far more satisfactory. The apparatus can be attached to any ordinary gas-pipe or gas-fixture in a few minutes, and no change in the meter or



THE ALBO-CARBON GAS-FIXTURE.

gas service is required. The carburetting vessel is detachable, and may be readily removed from the fixture for refilling with "carbon." This operation is quickly performed, and the whole appliance is so simple that it requires practically no attention. There is no complicated mechanism, and consequently nothing to get out of order.

The adaptability of this light for illuminating purposes under all circumstances is proved by the fact that it is now in use in many of the largest business-houses in this city and Brooklyn. Professor Stevens of Girard College, Philadelphia, says of it, "I have tested the albo-carbon light. . . . The burner consumed 2 cubic feet of gas per hour. One foot of common gas per hour equalled 2.5 candles, while one foot of the gas when carbonized equalled 8.125 candles. Regarding candle-power, the carbonized gas is equal to 3.25 times the common gas. Comparing the common gas with the standard 5-foot Argand burner, 5 feet per hour with the Argand burner equalled 17.20 candles; 5 feet of carbonized gas equalled 40.625 candles, which is 2.36 times the candle-power of the standard Argand. . . . The perfectly steady, soft light furnished by the albo-carbon burner adapts the light admirably for reading, for manufacturing establishments especially, and for general household uses."

The tests referred to above refer only to single lights: when the

albo-carbon light is burned in clusters of burners, a much more striking effect, with a far higher result in lighting-power, is produced. An eight-light cluster tested on London 16-candle gas gave 8.84 candles per cubic foot, while with the larger clusters the increase in candle-power is still greater. This light may be seen in use every evening at 728 Broadway, this city, the office of the Albo-Carbon Light Company.

THE NEW WESTON VOLTMETER.

IT is a law of human progress, nowhere better exemplified than in the industrial and mechanic arts, that all systematic and permanent advance depends upon our ability to determine quantitatively, in terms of some standard, the value of the various factors involved in any given operation or transformation. An idea of the crudeness of men's notions of measurement in former times as compared with the present, may be gained from the names of units or standards which have been handed down to us. Thus three barley-corns made one inch, the foot was the length of the king's pedal extremity, the hand is a measure still in use in estimating the height of horses, etc. Compare such notions with the accuracy required in modern machine-shop practice. It is, in fact, only when the value of work already done becomes known, that one is prepared to make further progress, as every step in advance demands increased refinement in the means and methods of measurement. As an instance in point, witness the mutual development of the steam-engine and the steam-engine indicator. Just as the indicator has advanced to a state of perfection such that its records are universally relied upon to detect faults in present apparatus, and intelligently outline the direction of improvement, so has there been a gradual advance in the construction of commercial electrical measuring instruments, serving a similar purpose, and tending to effect a similar result, in electrical engineering.

While it is true that thousands of engines are never indicated, and thousands of electrical appliances are never carefully tested, it is equally true, as a consequence, that useful energy is wasted, property destroyed, and money lost.

In electrical as well as in mechanical engineering, success necessitates the elimination of guesswork and the substitution of knowledge. Engines, dynamos, batteries, electric motors and lamps, are sold with a guaranteed efficiency and life, subject, however, to definite conditions as to use. It is generally because of the absence of definite knowledge as to when the imposed conditions are actually observed, that losses so frequently exceed profits. When measurements of the value of electrical appliances are actually made, the results are often discredited because of doubt as to the accuracy of the instruments used, and probably the general indifference to accurate work manifested by many electricians may be justly ascribed to the absence of reliable measuring instruments.

Most of the commercial electrical measuring instruments in use in this country to-day are of foreign manufacture. They may be briefly described as either of the permanent or electro magnet type. The former are in general disfavor, and unjustly so, because their defects are not inherent in the types, but are, rather, the natural result of poor design and construction. Those who have had much

FIG. 1.

experience with these instruments, of which the Deprez and Ayrton & Perry are examples, will recognize the fact that while these instruments are new, they are subject to rapid and serious changes in their constant. The rate of change, however, diminishes with age and use, up to a certain period, when they assume a condition of stability, and are thenceforth, in so far as the controlling force is concerned, reasonably reliable. Uncertainty as to when this condition of stability is attained necessitates frequent calibration, and is thus a serious obstacle to accurate work. A second defect is the heating error introduced when the instruments were kept in circuit even for the short time necessary to make readings.

Instruments of the electro-magnet type are, on the other hand, more generally in demand, because of the prevalent idea that they are not subject to errors arising from a variable controlling force. Errors, however, fully as serious as have been ascribed to permanent magnets, are not only common, but seemingly inherent, in this type, because of the magnetic persistency of the softest iron, even when subdivided. This error is most noticeable when readings are made with a rising, succeeded by a falling current, and often amounts to as much as twenty-five or thirty per cent. The best forms of this type of instrument are, perhaps, the ingenious

spring voltmeters and ammeters of Ayrton & Perry. These are, however, subject to serious heating and frictional errors.

Thus far we have mentioned only the most glaring defects common to commercial instruments. Another and almost universal defect is due to inaccuracies in the reading-scale. A great advance was certainly made when direct-reading instruments were substituted for those requiring a multiplying constant. It is a notable fact, however, that most of the direct-reading instruments, judged by the uniformity of their scale-divisions, follow the proportional law. This is extremely doubtful, however, and calibration generally reveals the fact that seldom are there more than two or three of the scale-marks correct. Printed or engraved scales may justly excite suspicion as to their accuracy.

The advent of an improved type of commercial electrical measuring instruments for direct-current circuits, in which the sources of error enumerated above are practically eliminated, and which are equally well adapted for both laboratory standards and commercial service, is justly to be regarded as an important step in the development of electrical engineering. The Weston Electrical Instrument Company of Newark, N.J., have recently placed upon the market a new form of commercial voltmeters and ammeters, designed by Edward Weston, the well-known electrician. The especial aim in designing these instruments has been not only to entirely eliminate such variable factors as have been enumerated above, but to add to the instrument certain valuable features mentioned below. To this end, the electrical, magnetic, and mechanical features have been so worked out as to insure permanence and reliability, coupled with simplicity, extreme accuracy, a wide range of scale-reading, and portability. The accompanying engravings (Figs. 1, 2, and 3) give general and detailed views of the voltmeter. It will be seen that the field of force is produced by a permanent magnet of peculiar form, while the deflecting body, carrying the index, is a light coil of insulated wire, whose motion, resulting from the dual fields established by the magnet and current circulating in the coil, is restrained by two coiled springs. The springs serve also to convey the current into and out of the moving coil.

That permanent magnets can be, and in fact are, daily made, which, after undergoing a process of artificial aging, remain thenceforth practically constant in strength when subject to ordinary use, is now generally acknowledged. In these instruments special care has been taken not only in the selection of steel and its proper magnetization and artificial aging, but the magnetic resistance of the acting field has been reduced to its lowest practical limit by the insertion of a central core of soft iron within the movable coil. This core is supported upon the magnet frame by a strap of diamagnetic material. The form of the pole-pieces is such that the deflecting coil constantly moves in a uniform field, and hence the deflections practically follow the proportional law; and a direct-reading scale, of nearly equal subdivisions, is obtained. The movable coil is wound upon a light frame of copper, which serves the double purpose of a support, and also, since it moves in an intense field of force, as a damper, thus making the instrument exceedingly dead-beat.

All of the more important parts of the instrument are made to gauge, and the bearings of the deflecting coil are jewelled. Interchangeability of parts, and the elimination of friction, are thus obtained. A difference of potential of about one and one-quarter volts, at the terminals of the movable coil, serves to deflect the index over the entire scale, the length of the scale being about six inches. This degree of sensitiveness permits, therefore, the construction of instruments having a wide range of maximum scale-reading by the simple insertion of differentially wound resistance-coils, in series with the movable coil.

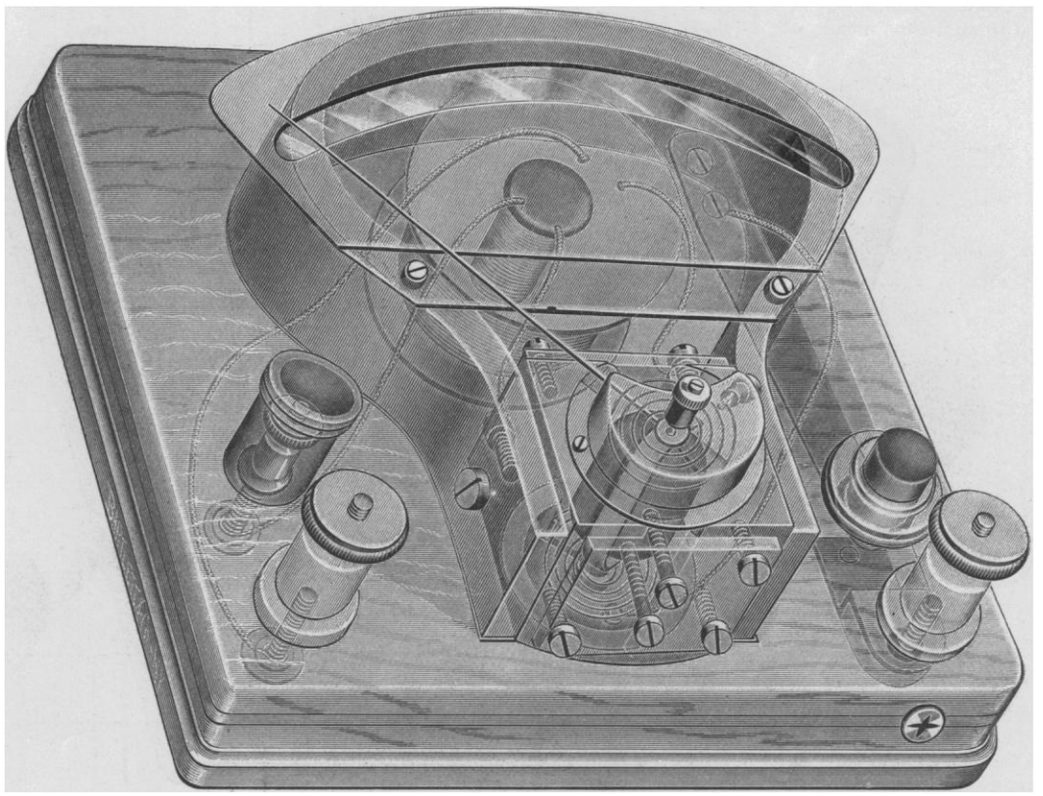


FIG. 2.

Figs. 1 and 2 exhibit the external and internal parts respectively of the new voltmeter, having a scale of double values, with a ratio of 20. The scale divisions for the upper values (Fig. 1) are single volts, while for the lower values they read one-twentieth of a volt. The single divisions are of such a size that one can easily read to one-tenth of a division; namely, to one-tenth of a volt on the upper values, and one two-hundredth of a volt on the lower. This form and ratio of scale values is useful for battery-work, and especially for storage-batteries. The lower scale values are used when examining single cells, or sets of two; and the upper scale values, when measuring the aggregate potential difference of a series of cells. In the former case, connection is made with the small binding-post (under the rubber cap) on the left, and with the larger binding-post on the right. In the latter case, connection is made with the two large binding-posts.

Another very important feature is the means afforded those not in possession of laboratory appliances of verifying the scale value by applying a single cell of some constant form, such as is to be found in any telegraph-office, to the terminals of the coil giving the lower scale-reading. The deflection noted serves as a standard for future comparison with the same or a similar cell, should doubt arise as to the effect of accidental rough usage.

All scale-readings begin at zero, and extend by practically uniform increments to the maximum reading. The range of scale-readings for instruments of a given maximum scale is thus greater than is common; and, as the divisions of each scale are the result of individual calibration and checking, the scale-readings are uniformly accurate. The temperature correction is negligible, and the instruments can be kept constantly in circuit, as their resistance is so high (averaging twenty thousand ohms) as to prevent any appreciable heating error. The ammeters have the same general appearance as the voltmeters, and possess the same merits of permanency and reliability.

In the hands of electricians and electrical engineers, these instruments are claimed to afford the means of obtaining measurements

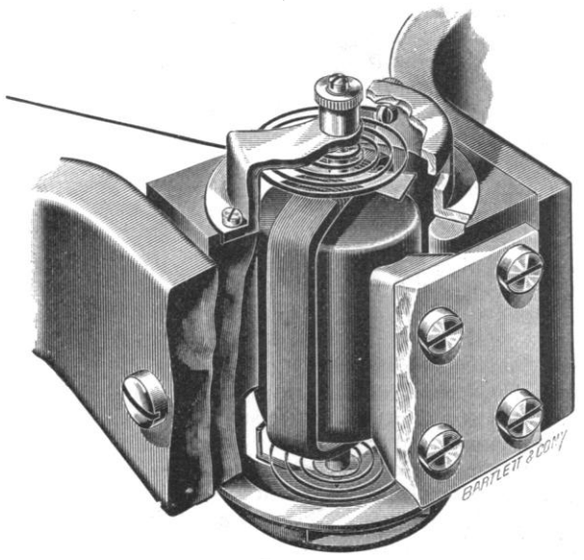


FIG. 3.

correct to within one-fifth of one per cent, and special instruments are made correct to within one-tenth of one per cent. If the limits of error were even ten times as great as claimed, these instruments would, it is said, possess greater accuracy than has been heretofore attainable in commercial voltmeters and ammeters. It is most certainly to be hoped that actual practice will substantiate the accuracy of these claims.

ELECTRICAL NEWS.

Hertz's Researches on Electric Oscillations.[1]

IN order to get resonance phenomena between two circuits, Hertz used an arrangement consisting of a straight copper wire divided into two parts by a discharger, the two halves being connected with the secondary of an induction-coil, while two hollow zinc spheres were arranged to slide on the halves. The micrometer circuit was made of such dimensions as to have a slightly shorter period than that of the discharge circuit, supposing the oscillations were really as rapid as was calculated. The experiments were made in two ways. First, the period of the micrometer circuit was increased: the result was an increase in the length of the spark that could be obtained in it, followed by a decrease, as the capacity, and therefore the period, became too great. Afterwards, the micrometer circuit remaining constant, the period of the discharge circuit was decreased, the result being, as before, an increase in spark-length in the micrometer circuit, followed by a decrease.

[1] Continued from No. 313.

We may fairly conclude, then, from all of these experiments, that the effects observed in the micrometer circuit were produced by oscillations in the discharge circuit of a period approximately equal to that calculated from the dimensions of the apparatus, in the neighborhood of a hundred-millionth of a second.

Hertz concluded, that, if vibrations were caused in the micrometer wire, there must be nodes (points of zero disturbance) somewhere

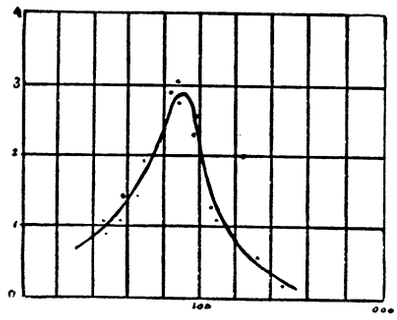


FIG. 5.

Curve showing relation between length of side of rectangle (taken as abscissa) and maximum sparking distance (taken as ordinate), the sides consisting of straight wires of varying lengths.

along its length. To prove this, he adjusted his micrometer circuit to resonance with the discharge circuit, making the gap in the former so wide that sparks were just able to pass. Then a sphere was made to touch different points along the wire, the result being a cessation of the sparks except when the point of contact was at the middle, showing that there was a node at that point. Again, by using a second micrometer circuit similar to the first, as in Fig. 5 (Fig. 7 in the paper), nodes were found to occur on *cd* and *gh*. When the wire connecting 2 and 4 was removed, the vibrations were not disturbed; but when the knobs at these points were brought close together, a slight spark was observed between them, the spark corresponding to a vibration with a single node at *ae*. We can, then, in the same conductor have vibrations with one or two nodes, according as we wish; that is, we can excite in it its fundamental

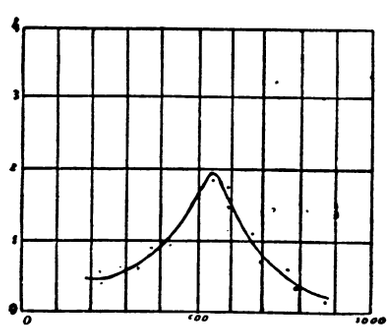


FIG. 6.

Curve showing relation between length of side of rectangle (taken as abscissa) and maximum sparking distance (taken as ordinate), the sides consisting of spirals gradually drawn out.

note or its first overtone. As to the higher overtones, Hertz considers it doubtful whether it is possible to produce them, for the results show that the damping effects must be considerable; and there are many secondary phenomena which show that irregular vibrations are superposed on the regular ones. To obtain the best results, Hertz observes that there is a longer spark in the secondary when it is exposed to the light of the discharge circuit.

Let us now call the discharge circuit the primary, and the micrometer circuit the secondary. The next experiment Hertz tried was with a primary circuit of straight copper wire, carrying at its ends zinc

spheres, and having a break in the middle for the discharge spark; the secondary being a circle of copper wire, broken by an air-space which was capable of adjustment by means of a micrometer screw. The two were adjusted until they were in unison, and the effect of the primary on the secondary was observed for different positions of the latter. There are in reality two electro-motive forces acting upon the secondary, — one an electro-static force, due to the rapid variation of the distribution of charge on the primary; the other an electro-magnetic effect, due to the current oscillating back and forth on the primary wire. Now, it is a matter of very great importance to find the effects of these two. In the lower part of Fig. 6 (Fig. 8 in the paper) the lines *mn* represent different positions of the secondary, which was vertical. The sparks in the secondary disappeared when the air-space was in the horizontal plane passing through the primary, and were a maximum for points at right angles to these. The arrows give the resultant force, which does not differ greatly from the electro-static distribution due to charges on *A* and *A'*.

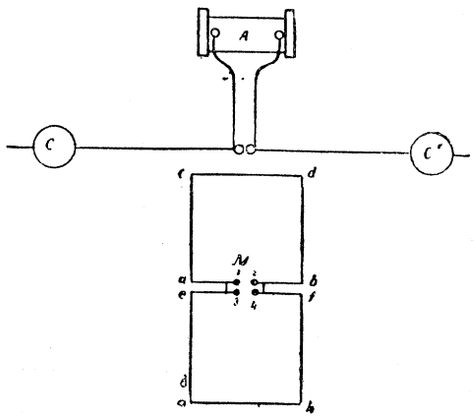


FIG. 7.

When the secondary was horizontal, as in the upper part of Fig. 6, in position *I* there were two maxima of spark distance, when the air-space was at a_1 and a'_1; in position *II* the maxima were at a_2 and a'_2, the distance at a_2 being the greater; in position *III* there was but one maximum, at a_3, with a point of disappearance at a_3; at *IV* there was a maximum at a_4, a minimum at a'_4; at *V* there was a maximum at a_5, a minimum at a'_5. From the position *III* to the position *V* the line aa' swung rapidly from a direction parallel to AA' to one perpendicular to it.

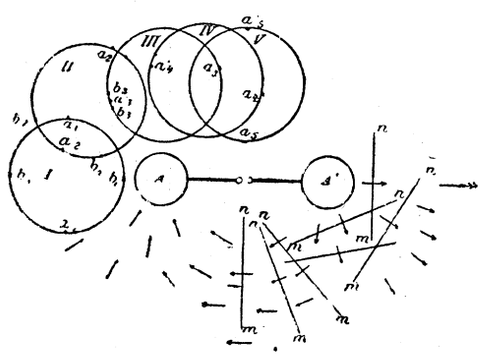


FIG. 8.

Now, what all these experiments mean is this: the electro-static force is more important than the electro-magnetic within the distances at which observations were made, excepting in the last cases, *IV* and *V*, where the electro-magnetic force comes in. But, as it is of the greatest importance to find out what takes place at a distance from the primary, Hertz extended his observations until the secondary was as much as 14 metres from the primary. At a distance of about 1.5 metres the maxima and minima became indistinct, but beyond this they were clearly defined again. From his observations, Hertz plotted out the distribution of force in the room, the result being like Fig. 7 (Fig. 9 in the paper), where the lines indicate the direction of the force, the stars representing the points where the direction is indeterminate. We see that at distances beyond three metres the electro-motive force is everywhere parallel to the primary, — that is, the electro-static effect is negligible, — and we find that the effect diminishes very much more rapidly in the direction of the vibration than at right angles to it. For less distances than one metre, the distribution of electro-motive force is practically that of the electro-static force.

There are two lines at all points of which the direction of the electro-motive force is determinate, — the line in which the primary oscillation takes place, and a line at right angles to it. But there are regions in which the electro-motive force becomes indeterminate: these form two rings around the primary, the projections being the stars in the figure. Since the electro-motive force within them acts very nearly equally in every direction, it must assume different directions in succession, for of course it cannot act in different directions simultaneously. The observations, then, lead to the conclusion that within these regions the magnitude of the electro-motive force remains nearly constant, while its direction varies through all the points of the compass during each oscillation. Dr. Hertz thinks the results very difficult of explanation, unless we suppose the electro-static and electro-magnetic electro-motive forces are propagated with unequal velocities, in which case we have within the annular regions two electro-motive forces at right angles, and differing in phase; and as a consequence the resultant will turn through all the points of the compass at each oscillation.

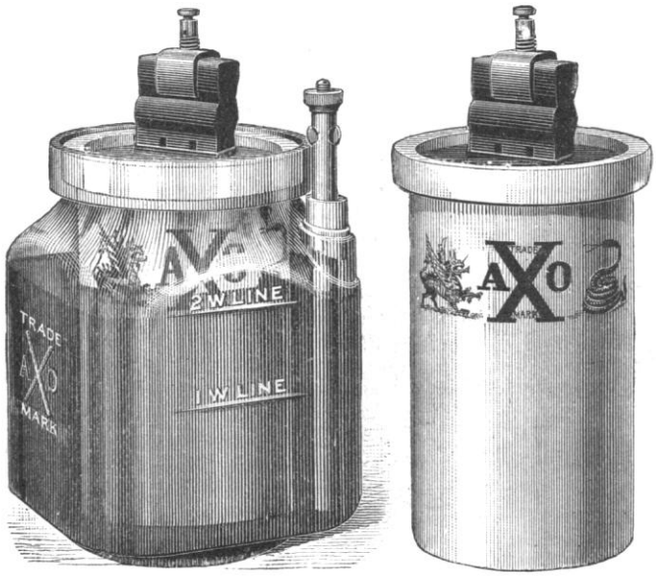
One great value of the above series of experiments lies in the fact that they enable us to put aside such theories as do not agree with the observed results; and, as there are a considerable number of theories, we are thus saved much confusion.

The next subject which Hertz took up was the idea of displacement currents in a dielectric, — an idea which underlies so much of Maxwell's work. Briefly, the assumption made by Maxwell is, that, if two conductors are charged positively and negatively respectively, then in the dielectric between them there is a corresponding displacement of electricity across any surface surrounding either. The displacement current lasts as long as the conductors are being charged, and has magnetic effects, just as a current in a conductor has. To show the existence of these displacement currents, Hertz arranged the experiment shown in Fig. 8 (Fig. 10 in the paper). Here the primary circuit consisted of the two conductors *A A*,' joined by a wire with the air-space for the discharge in the middle. The secondary circuit was adjusted in unison with the primary, and was placed in such a position that there was no sparking. If, now, a conductor *C* be held near *A A'*, equilibrium was disturbed, and sparks passed at *f*. On removing *C*, and approaching a dielectric, if no effect was observed, then the dielectric would be shown to have no magnetic action, and Maxwell's theory would fall to the ground. But on trying the experiment, a decided effect was produced, thus proving that the dielectric exerted magnetic actions, and that Maxwell's notion of displacement currents is in all probability correct.

ELECTRIC PLANTS IN THE NAVY. — The report of the naval inspector of electric lighting, Lieut. R. B. Bradford, contains a summary of the work performed under the supervision of this office. After describing the installations on the "Trenton," the "Omaha," the "New Hampshire," the "Atlanta," the "Boston," the "Chicago," the "Yorktown," the "Baltimore," the "Charleston," and the "Pensacola," the report goes on to say that search-lights are at times very useful, but discretion must be exercised as to when and how to use them. During the recent English evolutionary squadron exercises, the search-lights of the blockading squadron failed to detect the escaping ships of the enemy, which had, of course, all lights out, and every thing visible carefully colored a dead black. On the other hand, the enemy's ships which were not trying to escape used their search-lights to blind the eyes of the blockaders and interfere with the rays of their searchers. Recent experiments in Russia indicate that it is not an easy matter to disable a search-light with machine-guns and shoulder-rifles, on account of the light blinding the eyes and interfering with the aim. It is found in Germany, however, that if search-lights are placed

behind men with the beam of light on a target, very good practice can be made, so long as the men are in the beam, the sights of the guns then being illuminated; if, however, the men are out of the beam, and consequently invisible, the accuracy of the practice is much reduced.

THE AXO BATTERY. — The most widely used galvanic cell for "open-circuit" work — that is, for bells, burglar-alarms, telephones, etc., where the current is only taken out for short times — is the Leclanché, or some of its modifications. The cell has many advantages: it needs very little attention, its electro-motive force is comparatively nigh, there is no eating-away of the zinc when the cell is not working. The only troubles have been in the evaporation of the liquid, the creeping of the solution over the edges of the jar, and the corrosion of the



binding-post contact at the carbon pole. These defects are remedied in the new Axo type of Leclanché cell shown by the illustrations. Here the porous cup forms of itself the cover of the cell, which is hermetically sealed by pouring wax or paraffine in the space between the top of the cup and the edge of the jar. As the depolarization of the battery requires that there be a certain amount of ventilation, this is secured by deep grooves in the sides of the carbon, coming above the cover of the jar. It will be seen that the zinc passes through a separate hole in the side of the jar, which is closed by a rubber stopper. The connection with the carbon is made by a patented metallic clamp and thumb-screw, shown in the figure. Taken altogether, the Axo is an advance in galvanic cells. It can be sealed and left to itself, until, as must finally happen in every battery, the zinc and solution have to be replaced, when with very little trouble it can be practically renewed. For ordinary bell-work it would probably last a year or more without attention.

NOTES AND NEWS.

PROFESSOR SHALER of Harvard has returned from his tour of geological exploration through the Dismal Swamp.

— The Rev. Dr. George E. Reed, pastor of the Trinity Methodist Church of New Haven, is now at work upon his letter of acceptance as president of Dickinson College of Carlisle, Penn.

— Mr. F. Küstner has made a very interesting series of observations on the aberration of fixed stars, and, from certain discrepancies between early observations made by Struve and recent ones made by himself, arrives at the conclusion that the altitude of the pole, which is assumed to be a constant in the formula applied, is in fact variable. He found that in the fall of 1884, at Berlin, the polar altitude must have been 0.2″ greater than before and after that season. As this result appeared somewhat startling, he subjected other observations made at Pulkowa and Gotha to a thorough investigation, which proved the correctness of his view. Mr. Küstner attributes these variations to meteorological and hydrological phenomena which are caused by the action of the sun. Helmert's investigations tended to show that these irregular movements of matter might result in changes of latitude not exceeding a few hundredths of a second, while William Thomson concluded that these changes might be as great as half a second. From Küstner's observations, it appears that the real changes are intermediate between these two values.

— Professor Hill of the School of Geology of the University of Texas plans the establishment at the university of an educational museum which will represent in the broadest sense the geologic conditions — structural, economic, organic, and general — of the earth, and to illustrate these features as far as possible by Texas material accompanied by maps, models, and labels. This museum will exhibit not merely the extraordinary, but also the far more important and too little valued ordinary features of that State; so that any person, citizen or stranger, will find compactly arranged in the halls of the university a complete and instructive synoptical exhibit of all the diverse natural features of Texas. The museum will also be a medium of exchange with similar institutions outside the State. The attention which will be attracted abroad by properly prepared and representative specimens from Texas, conveying clear and accurate scientific information that can be disseminated in no other manner, will attract the earnest interest of a class of intelligent people who cannot be otherwise reached. The functions of the museum will also be distributive as well as collective, and its utility not confined to the university building, but disseminated throughout the State, it being the intention to select from its duplicates typical educational series for distribution to high schools connected with the university wherein the natural sciences are taught.

— A movement has been started in Norway, says *Nature*, for the despatch in the summer of 1890 of an expedition which will try to reach the north pole, and it is proposed that the leadership shall be offered to Dr. Nansen. Those who are arranging the plans maintain that no other country could furnish such a crew of experienced and hardy ice-men and arctic travellers as Norway, and that a winter or two in the arctic regions would affect these men very little. The intention is that an attempt shall be made to reach the pole by way of Franz Josef's Land, — a route advocated by the most experienced Norwegian arctic travellers as well as by several well-known men of science who have studied the problem. *Ski*, which have played such a prominent part in the Nordenskiöld and Nansen Greenland expeditions, would no doubt again be of great service.

— The board of overseers of Harvard College, at a meeting held Jan 30, adopted, after prolonged dicussion, the following vote: "Voted, that, in the opinion of this board, it is expedient that every undergraduate be requested to report in person early every morning, with a moderate and fixed allowance for occasional absences; that attendance at the exercises of each course be more rigidly enforced; that the system of advisers, somewhat as applied to special students, be extended to the freshman class; that the reports of the presence and absence of students be collected daily by monitors, and daily entered on the books; that no choice of studies made by a student be valid if it calls for more than three lectures or recitations on any day of the week, unless the choice has been specially allowed by the dean; that, in order to make it more difficult for students to prepare by a brief period of cramming to meet the tests applied, the faculty require all the instructors to provide tests of the progress of their students with sufficient frequency to enable them to enforce effectively Section 7 of the Regulations; that admonition be administered by the dean on his sole authority, and that the powers of that officer be so enlarged, at whatever increased expense it may be necessary to incur, that the records of attendance may always be ready for inspection by the proper officers; that the faculty be asked to prepare and report a series of rules, which, in their judgment, will give practical effect to these recommendations." This was adopted by a vote of 16 yeas to 4 nays, those voting in the negative being President Eliot, Dr. Phillips Brooks, Dr. Walcot, and Charles R. Codman. The carrying-out of these recommendations will depend on the faculty, which, it is understood, are opposed to their spirit.

SCIENCE:

A WEEKLY NEWSPAPER OF ALL THE ARTS AND SCIENCES.

PUBLISHED BY

N. D. C. HODGES,

47 LAFAYETTE PLACE, NEW YORK.

[Entered at New York Post-Office as second-class mail-matter.]

SUBSCRIPTIONS.—United States and Canada.....$3.50 a year.
Great Britain and Europe..... 4.50 a year.

Science Club-rates for the United States and Canada (in one remittance):

1 subscription	1 year		$ 3.50
2	"	1 year	6.00
3	"	1 year	8.00
4	"	1 year	10.00

Communications will be welcomed from any quarter. Rejected manuscripts will be returned to the authors only when the requisite amount of postage accompanies the manuscript. Whatever is intended for insertion must be authenticated by the name and address of the writer; not necessarily for publication, but as a guaranty of good faith. We do not hold ourselves responsible for any view or opinions expressed in the communications of our correspondents.

VOL. XIII. NEW YORK, FEB. 8, 1889. No. 314.

CONTENTS:

THE MANY KIND and appreciative words that our recent editorial comments on school matters have called forth are sufficient proof that we have succeeded in arousing an interest in this most important matter. Our Wednesday of last week the New York City Board of Education discussed the report of the committee on reform, but adjourned without taking any action. As we go to press, the matter is again under discussion. The character of the meeting of last week is now re-assuring. The "wrigsters" in the board received Mr. Webb's opening remarks in sullen silence, and, when finally one commissioner did find his tongue, it was to say that no marking system prevailed in New York city schools! This astounding statement is so transparently false, that we are quite at a loss to know why it was made. We can only interpret it as a sign that the opposition propose to treat the whole matter with an ignorant bravado. This attitude, however, will not be tolerated by the public nor by the independent section of the press. The question must be squarely met, and a vote must be taken. Another commissioner, one who knows nothing whatever about the schools as they now exist, proclaimed that they were perfect, and cited himself, a graduate of them, in evidence. This line of argument will hardly be accepted as conclusive. The well-known fact is, that abuses of the most outrageous kind exist, — favoritism, political methods, bad teaching, and the rest, — and they are wasting the lives of hundreds of thousands of children. The Board of Education *must* cope with them.

THE AMERICAN [AUTHORS'] COPYRIGHT LEAGUE has issued an appeal, asking the support, by all interested, of the Chace-Breckinridge Copyright Bill, which passed the Senate May 10 by 34 to 10, and is now before the House of Representatives. This is a compromise measure, the outcome of years of labor. Whatever its defects, this bill, the league believes, "will put a stop to the habit of piracy; will free American authors from the competition with stolen goods; will enable American writers to support themselves by their pens; will make American books cheaper by opening to them the broad home market now supplied with inferior foreign work; will give American books a chance to reach the American people, who now read many worthless books by foreign authors, reprinted in rival editions solely because they can be had for nothing; will result in securing to American authors important and growing foreign markets; and will take from our country the stigma of being the only great nation n the world which despoils the foreign author."

In this connection it is interesting to note, that, according to the Washington correspondent of the New York *Evening Post*, "the friends of the Copyright Bill have a plan for bringing up the bill in the House which they hope will be successful. The plan is to have a rule reported that will cover this bill. The great difficulty has been to induce the Republicans to agree not to insist that any such rule shall be amended so as to make it in order to call up pension-bills for passage. The Democratic Representatives are determined to resist any further pension legislation in this Congress. Some of the Republicans think that they have made all the 'record' as to pensions that is necessary, and that it is expedient to pass the Copyright Bill. There was a dinner on Saturday night, Jan. 19, which was attended by Mr. Houghton of Boston, Edward Eggleston, and others interested in the copyright matter, and by some of the leading members of the House, including Messrs. Cannon of Illinois, Long of Massachusetts, Adams of Illinois. Some of the Western members have been influenced by the concentrated attack upon the bill that has been made by the American Press Association, which furnishes the country newspapers with patent insides. The friends of the bill are endeavoring to counteract this influence, and to answer the stereotyped petitions which have been sent to the country newspapers for signature. Dr. Eggleston reports that a large majority of members of Congress, who at the opening of the session found their mails crowded with bogus petitions purporting to come from typographers, have had their eyes opened to the fictitious nature of these petitions by the representatives of the typographical unions who have visited Washington to assure members that the unions are heartily in favor of the bill, and that the opposition is, so far as they can find out, supported and paid for by certain British publishers who are afraid to lose business if the bill becomes a law. The fact that the *Union Printer* of New York, edited by W. M. Rood, and which is the official organ of the typographical unions in that part of the country, is giving hearty support to the bill by editorial articles, and joining hands with the organ of Union No. 2 of Philadelphia, shows the spirit in which the members of the craft are taking hold of the matter."

THE ANNUAL REPORT of the president of Harvard College is always looked for with interest, and for some years past *Science* has made it a custom to call attention to this report as soon as it is issued. The report of 1887–88 is before us; and, while it contains no features of striking interest, yet it chronicles a steady progress

along the line which the authorities of Harvard have marked out for themselves. Appreciative reference is made to the work of Professors Asa Gray and Ernest Young, who died during the year, and also to Robert D. Smith and James Freeman Clarke, whom death removed from the board of overseers. Mr. Eliot notes the fact that in 1888 the examinations for admission to the college were for the first time conducted exclusively on the new plan announced in 1886. It seems that the secondary schools and the private tutors have already responded in considerable measure to the new suggestions and requirements of the faculty. Of the 315 candidates who completed their entrance examination in 1888, 31 presented the history of the United States and of England instead of the history of Greece and Rome; and 93 presented elementary experimental physics, as recommended by the faculty, instead of descriptive physics and astronomy. Both French and German were presented by 110 candidates. The figures prove that the new requirements have already stimulated the teaching of modern languages in secondary schools, and have promoted the introduction of laboratory methods of studying physics and chemistry. It is pointed out that in the progress of converting Harvard College into a university of liberal arts and sciences, about the same gain was made in 1887–88 as in each of the years immediately preceding. "Progress," says President Eliot, "may be made in one or more of four principal directions: (1) in amplitude of instruction; (2) in freedom in choice of studies; (3) in better arrangement and co-ordination of studies within single departments; and (4) in *morale*." The gain in the volume of instruction during the year 1887–88 was about five per cent; that is, from 485 hours a week to 510 hours. In respect to freedom in choice of studies, the freshmen gained access to several departments from which they had previously been excluded; namely, Spanish, Italian, and music. President Eliot holds that it is to the advantage of every department that its elementary studies be open to freshmen, because otherwise the advanced courses of the department might not be reached in due season. In respect to co-ordination of courses, there was an entire recasting of the whole set of courses in physics, with the result of securing a better sequence of subjects and a more complete covering of the ground. Additional facilities were afforded for taking up advanced study and research in German and in Romance philology.

The *morale* of the college has been favorably affected by several causes. The voluntary method in the religious services gives satisfaction to teachers and students. "It meant the permanent removal of the question of conscience, and the drying-up of a constant source of irritation and ill feeling, and the reparation of what many believed to be a grave injury to religion, and the establishment at the heart of the university of a fresh, strong influence for good." Under a new regulation, also, the instructors have the power to exclude from their courses any students who neglect the work required of them. This power has been extensively used, and as a result the discipline and the progress of the students have improved. The question of athletics has been settled to the satisfaction of every member of the university, and Mr. Eliot adds of the faculty, "that they hold that dyspepsia is less tolerable than a stiffened knee or thumb, and that effeminacy and luxury are even worse evils than brutality." We notice, also, an interesting remark in this report regarding the physical condition of students holding scholarships. It seems that the college is now paying out more than fifty thousand dollars a year to students who need aid to complete their education. Heretofore it has been usual to pay no attention to the bodily condition of the recipients of this beneficiary aid, and it is believed that these recipients fall below the average of the whole body of students in health and vitality. It is now provided that holders of scholarships shall present themselves twice in the year to the director of the gymnasium to be examined as to their physical condition, and to receive suggestions as to the care of their health. The summer courses, the library, and the professional schools are all touched upon, and valuable information is contained in the appendices.

SCIENCE AND THE DICTIONARY.

ONE of the most important accompaniments of the progress of science, indeed an essential factor in it, is the increase of its vocabulary. Every advance in accurate observation, discovery, analysis, or constructive theory, brings with it a new term, or, more often, a group of terms. This multiplication of words is largely inevitable. The new things must, of course, generally receive new names, and the new ideas will not always fit into the frames of association in which the old words are set. The scientific demand for precision and brevity must be satisfied even if linguistic purity suffers. It thus happens that every year the language of science receives a large addition which students of science must understand and use. How very large this increment is, it is difficult, even for those who are familiar with several departments of science, to appreciate. Moreover, the process of growth does not stop with what is necessary. Unfortunately, the liberty which in many cases must be taken with the language has led many reputable scientific men to feel that they are free to do what they please with it, in any case. The result is a vast number of coinages which might have been dispensed with, but which must be learned and remembered, since they often become current through the reputation of their inventors. The number of such words increases at the rate of probably several thousand a year.

To this increment through direct coinage must also be added the numerous, and not less significant, specializations and enlargements of the meaning of established and even common words, such as "energy" and "potential." Every movement in science unsettles much that has been done before, and of this continuous re-adjustment its language is a true reflection.

It is obvious that at this point science can receive a great deal of help from competent lexicographic aid. While the dictionary is not, in many respects, an adequate exponent of scientific knowledge, it may be an invaluable record of the greater number of the elements or details of that knowledge. Its aim is, of course, necessarily to state merely what is or has been in the language it describes, not what scientifically ought to have been; but, if it is accurately and intelligently performed, this historical labor approaches in its value to science very near to original work. It is true, also, that the utility of the ordinary dictionary is limited by the narrowness of its definitions and the formalism which marks its treatment of its material; but these defects are largely conventional, and it is quite possible for an editor who understands the wants to be met, and who has the necessary disregard of traditions, to model a dictionary which will satisfy every reasonable scientific demand. In a word, the impossibility now felt of keeping track of the linguistic development not only of science as a whole, but even of one specialty, and the difficulty of guarding even established words from misuse or abuse, make the construction of a dictionary which will not only record the entire vocabulary of the sciences, but will record it and define it so fully and accurately as to conform to the needs of scientific men, one of the most urgent requirements of the time. It is therefore worthy of note that the attempt has been made in this country, and by American scientists, to produce a book of this kind. It is announced that the "Century Dictionary," which has been for some years preparing, under the editorship of Professor W. D. Whitney, is to be not merely a complete general and historical dictionary of common English, but also an equally complete dictionary of technical terms; and that this technical material, which has been obtained by searching all branches of scientific literature, has been put into shape by competent specialists, who have had in mind the necessities of their fellow-craftsmen, as well as the wants of laymen. It appears, thus, that an effort is seriously making to embody for the first time comprehensively, in lexicographic form, the scientific spirit and work of the nineteenth century; and while it is to be expected that the most direct result of the attempt will be the promoting of popular intelligence, it is also to be expected — from the reputation of the distinguished editor-in-chief and of his co-laborers, among whom are Professor J. D. Whitney, Professor E. S. Dana, Dr. Sereno Watson, Dr. Lester F. Ward, Professor C. S. Peirce, Professor T. C. Mendenhall, Professor R. H. Thurston, Dr. Elliott Coues, Professor Theodore Gill, and many others — that the interests of pure science will not be neglected.

SPEECH AND ALPHABETICS.[1]

I HAVE never practised offhand utterance on any subject. I have always had to write what I had to say; so that I have enslaved myself to a method which I cannot now hope to change. The method, however, has this advantage; namely, that it keeps one to the point, prevents rambling of thought and vagueness of expression, and so enables one to be exact to his intention, both in outline and detail. I do not mean that an address on such an occasion as the present should be read, but that, however little used, the presence of paper secures presence of mind. On the whole, therefore, I do not know that I should greatly care to change my method, even if I could.

We are called on to say something on the subject that most interests our thoughts. This requirement will, of course, furnish excuse for whatever of egotism there may seem to be in our response to the call. For my part, I can say, that, while I have from time to time ridden an occasional hobby, there has always been one subject of abiding interest which has persisted in maintaining prominence in my thoughts from my earliest days until now. That subject has been "Speech and Alphabetics."

I had hereditary leanings to the profession of teacher of vocal physiology, which no doubt influenced the current even of my boyish thoughts; and when, in 1841, I began to prepare myself for independent work, I sought to supplement what I may call the family knowledge which I possessed, by the study of all available books on the subject. I found, however, that but little assistance was to be obtained from this source; for the art of treating defects of speech had been shrouded in secrecy by nearly all its practitioners. My father was, in fact, the first to repudiate occult methods in the cure of stammering, and to practise his system openly. At the time I speak of, there did not exist in print, so far as I could discover, any precise directory for the processes of articulation. I aimed at teaching these processes, but could not find a single work that gave specific guidance as to what to do, or how to do it, in any given case. Under these circumstances, I had to investigate from my own organs and the organs of my pupils. I had many pupils, exhibiting wide varieties of defects and peculiarities, and the observations on these by day became the study of the night. I may add, however, that my night-work never interfered with day-work; that it invariably terminated not later than two in the morning, while the day-work invariably began not later than ten. This was very nearly the philosopher's division of the twenty-four hours, — one third for work, one third for recreation, and one third for rest. But my work and recreation were inseparable. Work was one half recreation, and recreation one half work, on the principle that "the labor we delight in physics pain," or, in other words, is recreative.

Years of this pleasurable devotion to one subject ultimately developed what I had sought in vain to find as a legacy from professional predecessors. In 1849 the first results of my labors were published under the title of "A New Elucidation of the Principles of Speech and Elocution," forming the kind of directory which I had desiderated before I began to teach. But this work was far from exhausting my phonetic material, which was still, moreover, increasing. I had become experimentally acquainted with a category of sounds far exceeding those in any language. The peculiar elements in Gaelic, Welsh, Scotch and Irish dialects, provincial and metropolitan English, American English, French, German, etc., — as well as those accidental sounds produced by stammerers, lispers, persons with cleft palate, deaf-mutes, etc., — were familiar to my ear and my vocal organs; and I sought long to incorporate them into one phonetic scheme, where each sound should find its place in due relation to every other sound. The process was the converse of that which had been tried for the collation of a universal alphabet. Eminent linguists had endeavored to collect from all known languages the sounds of each, and from these to frame an alphabet by which all tongues might be uniformly written. But no success had attended the efforts, because the identities and differences among the elements could not be satisfactorily determined. At a conference held in 1854, the object thus aimed at was finally abandoned, and declared to be impossible.

[1] Address by Professor A. Melville Bell, delivered in Washington, D.C., Jan. 28, 1889.

A different basis, however, seemed to me to promise a different result. My aim was to find a physiological instead of a linguistic basis for the desired universal alphabet. I therefore sketched out mouth-regions, divided as it were by lines of latitude and longitude, and endeavored to locate in my chart every sound which I could form or which I could distinguish, whether linguistic or not, so as to bring under review all the varieties that could be produced by the organs of speech. From such a category, I reasoned, the phonetic elements of any and every language might undoubtedly be selected and identified. The undertaking was an arduous one, filling up the night-work hours of many years; but it was at last accomplished, in the system of "Visible Speech" published in 1867.

Naturally, you will perceive, some aspect of my life-topic must still be one of the principal subjects of my thoughts. "Visible Speech" furnishes, in a universal alphabet, the necessary vehicle of a universal language, whenever, if ever, such a bond of human brotherhood shall become an accomplished fact. In the mean time, the system, as an educational implement, performs services both novel and valuable: so I might leave it now out of my thoughts. But I have recently been invited, from an influential quarter, to prepare a popular manual on the subject; and, in working at this, I have developed some new points, which will, I think, add greatly to the scientific value of the system.

The phonetics of our own language have lately claimed my chief attention. Our words have settled into forms irregular, incongruous, and bristling with difficulties to the learner. Every lover of the English tongue must wish that some means should be adopted to render it more easy of acquirement. To us who have mastered the difficulties, each word has, by association, become a thought-picture, of which every letter is a necessary part; and we look upon any disturbance of the orthography to which we are accustomed as we would upon distortion in a drawing. What is called "spelling-reform" is therefore, to perhaps nine persons out of ten, an abomination. If no other means were possible to lessen the labor of learning to read, the objectors to spelling-reform would no doubt yield to the inevitable, and lay aside prejudices and predilections from philanthropic motives; but they cannot be asked to do so while any method remains for obviating the tyro's difficulties without offending the educated, by changing the aspect of our literature.

Thinking on this subject, the idea occurred to let spelling alone, and make a perfectly phonetic version of our common alphabet by limiting each letter to its one most usual sound, discarding unnecessary letters, and designing new letters for unrepresented sounds, so as to form a separate initiatory system for children and foreigners. One primary object was to preserve such a resemblance to ordinary letters as might enable any person to read the new as readily as he does the old. By means of the amended alphabet, the time of learning to read may be reduced to a fraction of that required with common letters, while the exact sound of every word is deduced from the writing of the word itself.

There can be no doubt that a child, or a foreigner, who has learned to read from phonetic letters, will, with little or no further instruction, read also from common letters; and he will learn spelling by the mere contrast with phonetic writing. Spelling is thus always learned pictorially, by the eye, and not mentally, by rule.

One other point. English grammar, as compared with other grammars, is so simple that any alteration in it can scarcely be considered necessary; nevertheless the few existing irregularities may be removed from initiatory books without affecting standard English. I have pointed out elsewhere how this may be done.

English is already the most widely used of all tongues; and the adoption of the amended alphabet will facilitate its diffusion, so that it may speedily become the general medium of international communication throughout the world, — in briefer phrase, world-English.

Interest is hard to be aroused, except when some selfish object is to be attained. We have no personal benefits to be derived from the system which I advocate; but coming generations have, and so has all the outer world. Indifference is not a proper mental attitude in reference to such a subject. National pride, if no higher motive, should urge to effort, and liberality in furtherance of effort,

to render more perfect and more easily accessible, at home and abroad, our noble language and our glorious literature.

Now, I have not only told you the subject that most interests me, but explained the origin of my interest in it, and endeavored to excite your interest in it also. Pardon so much use of the first person. The narrative could not be cast in another mould.

SOMETHING ABOUT TORNADOES.[1]

WHAT are the local signs of conditions favorable to the formation of tornadoes? 1. The prevalence of southerly winds, with a gradual but continued increase of heat and moisture; 2. A sultry and extremely oppressive condition of the atmosphere, which is sometimes characterized as "sticky," or so quiet as to call forth the remark that "there is not a breath of air stirring;" 3. The form, motion, character of development, and place of formation, of clouds. The sudden appearance of ominous clouds, first in the south-west, and then almost immediately in the north-west and north, is sufficient to attract the attention of the most casual observer. In nearly all instances, these premonitory clouds are unlike the ordinary formation which signifies rain, and perhaps a thunder-storm. If the clouds are light, they resemble smoke rising from a burning building; if dark, they present a deep greenish hue, which appears to increase in intensity as the storm advances. Sometimes these dark clouds appear as densely black masses of smoke, rolling upward from the chimney of an engine. The motions of the clouds are peculiar, in that they appear to be rushing from every quarter towards a common centre, making the incipient stages of a gyratory motion in the cloud region. The next step in the progress of development is the appearance of a small darting tongue of cloud, which suddenly proceeds downward from the centre of commotion, and ultimately reaches the earth as the full-fledged funnel-shaped tornado-cloud.

This brings us to consider what are the signs of its approach. The tornado-cloud is, of course, not visible from all directions while sweeping the earth. The limit of vision is necessarily greater in some cases than in others, depending upon the topography of the intervening country. Where the funnel-cloud cannot be seen, its existence can readily be distinguished by the peculiar roaring noise which is likened to the rumbling of distant thunder, or the approach of a heavy train of cars. The noise is said to resemble the "sighing of the wind through the forest." As the storm approaches nearer, the sound increases in intensity until the final crash of the elements, which comes with the suddenness of an explosion. The noise is sufficiently peculiar and distinct to create an alarm, and, as a means of warning, must not be ignored. A few moments before the assault there is a death-like stillness in the air. The observer's eye catches the absence of any movement in the leaves upon the trees, which a moment before danced in a gentle wind. The ominous silence portends grave results, and requires that no time be lost in seeking the most perfect means of safety.

The form of the tornado-cloud in individual cases is somewhat variable; but it always tapers from the top downward, the smaller end being nearest the earth. It is described by eye-witnesses as resembling an "elephant's trunk," "balloon-shaped," "egg-shaped," "basket-shaped," etc. While passing along its path, the cloud is characterized by four distinct motions, which may be designated as (1) the "progressive motion," generally from some point in the south-west quadrant to some point in the north-east quadrant; (2) the "whirling or gyratory motion," always from right to left, or contrary to the movements of the hands of a watch with the face upward; (3) the "curvilinear motion," where frequently the cloud rises from the earth, breaking the continuity of its path for a distance of several rods to as many miles, then returns suddenly to the earth with renewed energy, continuing its violence as before; and (4) the "oscillatory motion," a swaying from side to side of the central line of cloud movement. (This motion is sometimes quite sudden, but generally it is a moderately slow motion, and easily identified: the regularity of it depends upon the frequency and severity of the indraughts of air from the south side of the storm's path into the vortex of the cloud).

[1] Portion of a paper read before the National Geographic Society of Washington, Nov. 16, 1888, by J. P. Finley, continued from *Science*, No. 313.

It is important here to state that the south or right-hand side of the tornado is the most dangerous part of the storm, as it is also in the case of the cyclone. On this side the inflow of air toward the vortex coincides both with the progressive motion of the tornado and with the general easterly movement of the "low," thereby increasing the velocity of the southerly currents. On the north or left-hand side of the tornado the incurving winds oppose the direction of the currents advancing to the vortex, and therefore the force of the wind is very much less on this side: it is therefore the safest side of the storm. The tornado-cloud is swept along by the general currents prevailing in the south-east quadrant of the "low," and whatever may suddenly affect these movements will also extend its influence to the tornado-cloud, and thus increase or diminish its gyrations, sometimes to the extent of withdrawing the cloud entirely from the earth. The tornado continues in the full manifestation of its power until the force arising from the gyrations is no longer adequate to keep the pressure and temperature in the vortex low enough to cause condensation; and therefore the lower part of the cloud vanishes first, the decrease of power continuing until nothing appears on the funnel, and a dark, irregular mass of cloud marks the spot from which the spout had previously depended.

"Windfalls" are the tracks of tornadoes through forests, as shown by the prostrated and confused masses of timber. In many cases there remain but the skeletons of these ruins, and their location is known only to Indians, trappers, hunters, and surveyors. There is not a State east of the Rocky Mountains that has escaped these serrated tracks through its forests, and the record of their occurrence will in many cases be found upon the plats of the early State surveys. Windfalls both of recent and of very early date are still to be found in the forests east of the Mississippi. The late Professor I. A. Lapham of Milwaukee, Wis., attached to the signal corps in 1870–72, made, in the latter year, a very exhaustive and interesting report on the windfalls of Wisconsin. As the result of a very careful examination of the plats of public surveys made within the State, he discovered and marked upon a chart the location and approximate length of path of three hundred and sixty windfalls or tornadoes.

The successful protection of life depends upon the position and surroundings of the observer on the approach of the tornado, the character of motion possessed by the tornado-cloud at the time, the width of the path of the storm, and the velocity with which it is moving.

The following precautions have been determined upon as the result of careful investigation, observation, and experience: 1. The south side is the dangerous portion of the tornado, the north side is the safe portion. 2. In the open country, never undertake to escape from a tornado-cloud without first making sure of the points of the compass, and that the direction which you propose to take is in a line at right angles to the path of the advancing cloud. 3. If the cloud is moving to the north-east, then the line of escape is to the north-west; if to the east, then to the north. Stand facing the advancing cloud in the direct line of its approach, and the safe side is always to the right. 4. To make escape certain, the tornado-cloud should be about three-fourths of a mile distant. This gives the observer a momentary chance to ascertain the character of motion it possesses, the velocity of progression, the width of the path, and the points of the compass. These estimates must of necessity be approximate, but can be made sufficiently accurate to be depended upon. At a greater distance than three-fourths of a mile, it would be difficult, in most cases, for the observer to obtain this information with any degree of satisfaction, unless the atmosphere was clear, and the cloud advancing over the open prairie.

A frame building is safer than one built of brick or stone. The former is more elastic, and holds together longer. The latter goes down in the first crash, and the *débris* is whirled into a heap in the centre of the foundation. This is especially the case where a brick or stone building stands alone. In a block of such buildings, one structure supports another, and there is not quite so much danger of entire destruction. In any event, however, the brick or stone building is the most dangerous, because it so readily crumbles and separates into falling masses, that the inmates are never safe from injury.

In a frame structure the safest place is in the cellar, but in a brick or stone structure it is the most dangerous. In the former case, if the building is destroyed, it is invariably carried away from the foundation. In the latter case the cellar is filled with *débris*.

The safest building to construct is one made entirely of wood, with a "barn frame," and not exceeding one story and a half in height. Where several buildings are connected together in a row, the height may be increased one or more stories with safety. No structure that rises above the earth, however made, can resist the violence of the tornado, and therefore no building is safe as property, or as a resort to protect life. Under all circumstances, whether in a building or in a cellar, refrain from taking a position in a north-east room, in a north-east corner, in an east room, or against an east wall.

The tornado-cave offers absolute security to life and limb, and nothing can replace it for that purpose. This retreat may be constructed as a cellar-cave or as a "dug-out." In the former case an excavation is made in the west wall of the cellar, on a level with the floor of it, and carried under ground until a sufficient distance is reached to provide comfortable quarters for those who propose to occupy the cave. The overhanging roof must be supported by heavy timbers, and then arched over with masonry of brick or stone. This extra precaution concerning the roof is necessary to provide against any serious damage to it by falling timbers or heavy masses of *débris*. The excavation is made into the west wall, because the storm, always approaching from the west, will carry the *débris* away from that side. But even this favorable position does not preclude the probability of *débris* being thrown upon the cave by the whirling currents of the vortex. The extra care bestowed upon the roof is money and time well spent. Careful attention should be given to ventilation and drainage, and to making the retreat in every way as convenient and comfortable as possible. The extent to which this suggestion can be complied with will depend upon the pecuniary ability of the person concerned.

The "dug-out" is a tornado-cave, not necessarily connected with any building. The results to be secured are the same as those derived from the use of the "cellar-cave." The cost of a properly constructed tornado-cave, including material and labor, will range according to the quality, character, and strength of the material with which it is built, together with the price of labor, from a hundred and fifty to three hundred and fifty dollars. Such a cave will comfortably accommodate ten persons.

The rush of air into the tornado's vortex, and therefore the violence of the wind, depends upon the difference of barometric pressure between the inside and the outside of the storm. This difference has been observed to be nearly three inches, and may be very much more, for observations have never been made in the centre of the vortex. A gradient of three inches, however, will give a velocity of 323 miles per hour, which will exert a pressure of about 260 pounds per square foot against a surface exposed at right angles to the direction of the wind.

The explosive force of confined air in a tornado is enormously great; and frequently it is to this energy, rather than to the direct force of the wind, that the destruction of buildings is due. As a tornado-cloud passes over a building, if the air within is confined by closed doors and windows, and cannot readily escape, the explosive force, due to a very great difference in tension between the air inside and outside of the building, bursts asunder the walls, and throws the roof upward to a considerable distance. Eye-witnesses state that under such circumstances roofs have been uplifted a distance of five hundred feet. Cellar-doors have been blown away from their fastenings in the face of a strong wind coming directly against them, and corks have been blown out of empty bottles by the sudden expansion of the air within them. Many almost incredible instances of extraordinary violence by the explosive force of tornadoes could be given, but want of space forbids more than this general reference to such manifestations of the tornado's power.

There is no fact or record to show that an electrical discharge, or any manifestation of atmospheric electricity, ever directly and entirely destroyed a large stone or frame building; ever lifted a locomotive from its track; ever carried an iron bridge from its foundation, and twisted the framework into a shapeless mass; ever rolled a bowlder from its bed in the ground; ever embedded one piece of timber into another, after having carried the former several hundred yards in the air; ever carried bedding and clothing in the air for miles; ever elevated to considerable heights in the air, columns of water from ponds, lakes, and rivers; ever lifted animals from the earth and carried them over buildings; ever drew the water from a cistern; ever twisted a tree from its stump; ever turned a building upside down, or end for end, without otherwise injuring it.

Any method of reasoning which assigns tornado-development to planetary influence is, equally with the electrical theory of their origin, without foundation. We have but to realize that in the formation of the tornado, and other local storms of a similar character, the entire action of all the forces involved, even in the energy of the sun's heat, is embraced in that portion of the atmosphere within from two to three miles of the earth's surface.

Any influence emanating from the movements, conjunctions, or other periodical mutations of the heavenly bodies, distant hundreds of thousands and millions of miles, can only reach an infinitesimal amount, and is entirely inappreciable in its effects upon the atmosphere to produce local or general disturbances, especially near the earth.

It has been asserted that the conditions which give rise to the formation of the tornado-cloud result from the effect upon the atmosphere of the mere revolution of the planets in their orbits; that the circular movements in the atmosphere are propagated and continued by such influences. The effect is likened to that which would result from the whirling in different directions, in a large vessel of water, of several globes attached to the same spindle. Upon withdrawing the globes, after a number of revolutions, the surface of the water will be found covered with a network of eddies. The inherent fault of this simile is the fact, that, while the illustration provides for the circular movement of the bodies within the medium which is set in motion to give the characteristic whirls or eddies, the subject of illustration, the planets, perform their revolutions, not in the atmosphere (the medium to be set in motion), but millions of miles away from it, in another medium, concerning which little is known. The failure properly to apply the method of reasoning by analogy often leads the novice into making the most ridiculous assumptions. It would be more reasonable to assume that the revolution of the planets gave rise to the great disturbances of the atmosphere, embracing extended regions of country, which are known on the weather-map as "highs" and "lows;" but even here the same difficulties operate, although not so extravagantly as in the case of the tornado, with the narrow path of a hundred yards or more.

To forecast successfully the time and place of any atmospheric phenomenon is a difficult matter, largely in proportion to the area of country brought under the influence of the particular disturbance. There are, of course, other elements which enter into the calculation to render the problem, except under the most favorable circumstances, an extremely complicated one, where the accuracy of results is demanded. It is well known that the tornado has the most circumscribed area of all storms, while its violence has no equal in the entire range of meteorological phenomena.

A large amount of field-work, and instrumental and general observations extending over many years, relating to the conditions of formation of this peculiar class of storms in every part of the country where they were found to occur, was necessary as a foundation upon which to base investigations as to the origin, mode of development, and means of prognostication. I began this work, in addition to other duties, in 1879, under directions of the chief signal officer. The first field-work was done in that year, the second in 1882, and the third in 1885. Various reports were prepared and published concerning the development of particular storms, the origin and general characteristics of tornadoes, and the relation of tornado regions to areas of low pressure.

It was found that tornadoes generally occurred at a certain time of day; generally moved in a certain direction; were generally preceded by certain conditions of wind direction and velocity, and by a certain gradient of temperature; generally occurred in connection with a well-defined area of low pressure, and with a "low" of certain form and trend; and generally occurred in a certain

quadrant (south-east) of the low-pressure area, at a certain distance from the centre of the "low" as marked on the weather-map, in certain regions of the country and in certain months of the year, and in groups having parallel paths of progression and at distances between of but a few miles.

Official tornado-predictions began at the Signal Office, experimentally, on the 10th of March, 1884, and were made twice daily at 7 A.M. and 3 P.M., Washington time. The predictions were for certain districts, that portion of the United States embraced between the 77th and 102d meridians being divided into eighteen sections, with arbitrary boundaries. These prognostications terminated on Sept. 20, 1885; and during the season embraced by the work, all of the well-defined and most destructive tornadoes were predicted for the districts within which they occurred, from five to eight hours in advance of the reported time of their appearance.

After May 10, 1886 (the following year), the official predictions were announced to the public in accordance with the following order of the chief signal officer: "The indications officer will give special attention to conditions favorable to the development of severe local storms and tornadoes. When the reports justify the prediction of these storms, they will form a part of the general indications, the prediction to be that conditions are favorable for the occurrence of severe local storms or tornadoes, giving the names of the States where such storms are expected to occur."

It will be observed, that, upon deciding to make tornado-predictions part of the general indications issued daily to the public, the character of the districts was changed from those determined by arbitrary divisions, to those designated by State lines; in other words, the States themselves. Commencing July 1, 1886, a special chart (No. 5, Dew-Point and Local Storm Chart) was made up daily in the indications room of the Signal Office to furnish information from which tornado-predictions could be made. This chart was discontinued on July 1, 1888, and replaced by the general weather-chart from which the regular indications are made. Since Sept. 20, 1885, no official verifications of local storm-predictions have been made, but the results observed from the combined indications are in a measure satisfactory.

Personally, I am of the opinion that the forecasting of conditions favorable to the development of tornadoes, and designating the quadrant of a State in which such conditions shall give rise to local signs that the inhabitants of that section can rely upon, are entirely practicable. By this admission I do not mean to convey the idea that the exact path of the funnel-shaped cloud can be indicated in the despatch, for that would be impossible except by chance. The average width of the tornado-track is only a few hundred yards; and several of these storms may occur in the same county, with entirely independent paths of destruction, and distinct cloud-formations.

It doubtless appears that the quadrant of a State, especially the larger ones, is a very extensive area to cover with a single tornado-prediction; but the fact must not be overlooked, that, where the conditions are favorable for tornadoes, storms having various degrees of tornado violence occur here and there over a very large section of country. Therefore the scheme of local storm-predictions for State quadrants would seem to possess the elements of success; for, while the peculiar funnel-shaped cloud might not appear, the conditions would be such that local storms of great violence would occur, and destruction to life and property ensue.

Although, of course, the area here indicated is quite variable in extent, yet it possesses the decided advantages of definiteness, familiarity to the people who are interested, and brevity of expression in rendering a concise despatch. The local signs of tornado-development are certain, easily observed, and well defined. With the people well informed on these points, and there is no reason why they should not be, the prediction of conditions favorable to local storms, issued from some central meteorological office, would, if successful, supplement the local signs with beneficial results. Failures in the official predictions would not only bring out more distinctly the importance and reliability of local signs, thus creating an interest in their careful observance, but would obviate the occurrence of serious results when wrong predictions were made, as the people would test their trustworthiness by appeal to the "local signs."

With the appearance of every new problem in science, especially if its solution involves the welfare of mankind or any great number of people, there is made the most strenuous effort to obtain deductive results, without due regard to proper methods of investigation. This is all quite in accordance with the inclination of human nature frequently to want without reason, but the true scientist knows that such demands cannot be complied with in safety.

People clamor for adequate means to destroy the tornado-cloud by a single blow, sometimes that can act with the rapidity of the electric shock; and because the article cannot be supplied in order, in quantity, and in style, to suit customers, we are informed by some critics that investigation thus far has been fruitless, and that our efforts to expose the nature and origin of tornadoes are the mere vaporings of a vivid imagination.

In this age of inventions and glittering geniuses, it is not surprising that the sufferings and the necessities of the tornado-stricken people have received attention; but, as usual, such attention has been more to the profit of the scheme and schemers than to the advantage of those whose credulity made them the victims of an overweening confidence. The festive and irrepressive lightning-rod pedler has appeared upon the scene, and offers with great gusto a beautifully wrought metallic rod, to be attached to buildings with gilt fastenings, terminating near the chimney or cupola with a resplendent brass rooster or other decoration, which, while serving the purpose of a wind-indicator, is, together with the mysterious rod connecting it with the earth, a perfect protection against the tornado-cloud. How the result is obtained is a secret of the inventor. The purchaser must not inquire into the nature of this mystery, as his success with the venture depends solely upon an abiding faith and the requisite shekels.

There are other plans and devices deserving of a little more recognition, but they are wholly wanting in the essentials that shall make them reliable and capable of practical application at the moment of supreme danger. Among these may be mentioned (1) an arrangement to explode an underground magazine by electricity when the tornado-cloud approaches a town, a mill, or any group of buildings to be protected, the explosion to take place while the cloud is passing over the magazine; (2) an arrangement of high poles, electrically connected with each other and the earth, and covering about an acre of ground, the top of the poles to be furnished with long, sharp metallic points, so as to draw off the electricity of the tornado-cloud, and thus dissipate its energy at once, upon reaching the field of poles; (3) a cable to anchor a building safely against the fiercest tornado, and an insurance policy to cover all damages that may occur from the cable giving way; (4) an arrangement to keep kegs of gunpowder in a properly protected place to the south-west of the building, and, upon the approach of the tornado-cloud, courageous men to take out the kegs and place them in the path of the approaching cloud, the powder to be fired at the right time to destroy the cloud; (5) an arrangement to construct immense stand-pipes of heavy wrought iron, about five hundred feet high and one hundred feet in diameter, these pipes to be placed upon heavy masonry piers about ten feet high, and so constructed as to permit a free circulation of the air underneath, and upward through the centre of the pipe. The plan involves the erection of a considerable number of these pipes in the tornado regions, the requisite number to be determined by experience. It is expected that these great pipes will serve as vent-holes for the harmless escape of whirling eddies in the atmosphere, which otherwise might develop into destructive tornadoes. It is further claimed that these pipes may serve to increase the rainfall at any place by causing, artificially, the upward rush of a large volume of air, the moisture contained therein being condensed by the cold of elevation. The initiatory upward movement at the base of the pipe is induced by an open fire built on the ground, within the pipe and near the centre of the base. Of course, the physical principle involved is the upward movement of heated air, and the inrush, at the point of inception, of the surrounding cooler air, thus giving rise to an upward flow of more or less power, according to the amount of heat applied and the volume of air affected.

The limits of this paper will not permit of a critical discussion of the merits of the various mechanical devices for the destruction of the tornado-cloud, or even to mention them all. Suffice it to say,

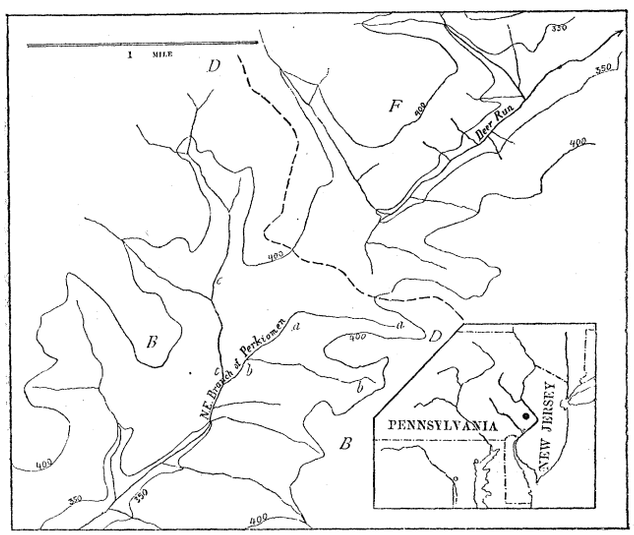
that the writer is of the belief that all efforts directed toward the accomplishment of the destruction or dissipation of the tornado-cloud by any known and practicable means, will fail of realization.

Mechanical appliances are wholly incapable of successfully coping with the forces of the tornado, which, unlike the whirlwind and waterspout, arises from the unstable state of the atmosphere in the cloud region, where the tornadic gyrations commence, and are afterwards propagated downward to the earth's surface. The tornado is controlled by the operation of forces far above the ground.

A RIVER-PIRATE.

THERE is a little river-pirate in eastern Pennsylvania unsuspected by its rural neighbors. It is in a quiet, well-watered farming district, where the streams, as a rule, are bent only on minding their own business, and not interfering with their fellows; and yet one of them is a confirmed pirate, and goes on unhindered in its robbery.

The pirate is Deer Run, and its victim is the north-east branch of Perkiomen Creek. The head waters of the latter have been captured, and led away from the basin where they were born and passed their youth, and thus diverted to swell the surreptitious vol-



ume of the intruder. The affair has happened in this way. The country hereabout was in ancient times a surface of faint relief, at a lower stand than now, traversed by idle streams; but, in consequence of elevation to a greater altitude, the streams have revived their lost activities, and set to work to sink their channels and open out their valleys in the process of reducing the land to its proper level again, even with the sea; for land finds its level, like water, but more time is required before the level is assumed. The streams that drained the country when it was elevated adopted such faint inequalities as they then found for their first settlement, and have since been engaged in perfecting their courses as best they could, cleaning them out, deepening them, and adapting them most exactly to the best transportation of land-waste. In the processes of adjustment thus called forth, every stream struggling for its own existence, it sometimes has happened that a stream with steep head waters has seized drainage area from the flat-lying head waters of an adjacent basin; because, other things being equal, the waste of the surface is fastest on the steepest slopes, and hence the steeper streams have gnawed more quickly into the land-mass than the flatter ones, and the divide between a pair of contesting streams has consequently been pushed in the direction of the fainter descent.

The abstract possibility of this process cannot be questioned; but one might well hesitate before accusing so innocent-looking a stream as Deer Run of such underhand designs. Yet the evidence of its piracy is too direct to be doubted.

In the first place, the region that the two streams drain has been accurately surveyed by the Philadelphia Water Department, and the maps thus secured have been published by the Geological Survey of Pennsylvania. The facts of the case are thus brought clearly before the world, after long remaining in unsurveyed obscurity. It is from one sheet of these maps that the accompanying figure has been traced, omitting the wooded areas and dwellings. The smaller map in the corner indicates the location of the district under discussion in the south-eastern corner of Pennsylvania, north of Philadelphia and west of Trenton. In the next place, it is to be noted that the slope of Deer Run from the divide *DD* is twice as steep to the north-east as is that of its victim to the south-west. Deer Run descends sixty feet in a mile at its head: the Perkiomen branch descends only thirty feet in the same distance. Again: it appears that the two streams, flowing on the same line but in opposite directions, both follow the same bed of shaly sandstone in the rock formation (triassic) that underlies the district: there is, therefore, no inequality of structure on the two sides of the divide to determine a difference in the rate of head-water weathering. In so short a distance as a mile or two, it cannot be thought that there is any difference in rainfall or other climatic element of significance; and, if exposure to sunshine be a factor of value in aiding the denudation of a surface by strengthening the diurnal variations of temperature in the soil and increasing the number of winter thaws, this advantage would be with the Perkiomen. Leaving this aside, it appears, that, except for difference of slope, the streams are in similar conditions, and any inequality in their action must be referred to the control that the slopes exert. As the control exerted by the slopes is distinctly in favor of Deer Run, we must conclude, that, if a patient observer should take his stand on the higher ground near by, he would certainly see the divide *DD*, migrating, rather slowly to be sure, to the south-west. After a time the uppermost side-stream of the Perkiomen branch, *aa*, would be tapped by the insidious operations of the pirate; and, powerless to withstand the temptations of a more facile descent, it would turn from its parent to join the volume of its captor. In time another side-stream, *bb*, would be led astray; and thus Deer Run would extend its territory at the expense of its more inert neighbor, and the divide would in time be shifted to *BB*.

Now, it is noticeable that all tributaries thus acquired by the pirate would enter the head of its main channel in a back-handed manner, like the barbs at the point of an arrow, indicating by this abnormal arrangement their early training in accordance with the habits of the Perkiomen family, where they were brought up. But if this process is going on now, we must be persuaded that it has been in operation in earlier times also, and that results of the kind now predicted for the coming ages should already be visible as the product of those gone by. Such is undoubtedly the case. Deer Run bears at its head at least three small side-streams, which still manifest in their directions the clearest indications of Perkiomen habit; and thus it must stand convicted not only of piratical intentions for the future, but of piratical practice in the past.

If the reader should, perchance, be seriously inclined to geographic study, he may find many accounts of this kind of interaction among rivers in the writings of recent authors. Gilbert has considered examples of the process in our Western Territories; Löwl and Philippson have pointed out a number of instances among the rivers of Europe; and Heim has shown how the picturesque little lakes at the head of the Engadine result from the capture of head-water streams by the steep-sloping Maira from the more steady-going Inn. As our intimate acquaintance with the geographic development of our country is furthered by the publication of good topographic maps, we shall undoubtedly find many cases of head-water adjustments. The Atlantic-Mississippi divide, from Pennsylvania to Alabama, should be especially rich in them.

Yet, if what is one man's food is another man's poison, it may be that what is one man's crime is another's virtue. It is only in false allegory that we can blame Deer Run for having taken what once belonged to the Perkiomen; and instead of calling the capture of head waters a piratical act, which at best is but an *ad captandum* term, it should better be regarded as a sharing of another's burden of labor, and a willing assumption by the more active stream of its fair proportion of the work to be done by the whole river system to which it belongs. Instead of gauging the disposition of streams by

likening them to human pirates, and berating Deer Run for what it has done, let us look at the affair from the point of view that a well-disposed river would take.

When this district was lifted from its former lowly estate, the streams found a new task set before them. They at once set to work at it with the best disposition in the world. But, in their immaturity, they accepted without question such guidance as the faint relief of the surface afforded, only to discover later on that the primitive division of territory was unadvisable as a permanency, because it was not adapted to the best accomplishment of the work assigned to them. It is found that a re-adjustment of boundaries, in certain cases, will allow a more economical transportation of land-waste to the sea by better-arranged channels; and, when this becomes apparent to a stream, it at once obeys its new opportunity, whatever force of habit it may theretofore have had. If the ideal of a stream's life were always to persevere in the channel that it at first selects, this readiness to change its course would be called fickleness; but when we perceive that the true ideal of a stream's life is to carry towards the sea its full share of the waste of the land that its river system drains, then we may recognize a virtuous willingness to the performance of duty in this immediate forsaking of an old course, and adoption of a new one, where its work can be done better and quicker. It is the unwisdom of youth that is thus corrected by the better choice of maturity, and many a river has thus improved its early ways. It is undoubtedly true that Deer Run has taken something of what once belonged to the Perkiomen, but it was not seriously that the name of a river-pirate was given to it. W. M. D.

A POPULAR OBSERVATORY.

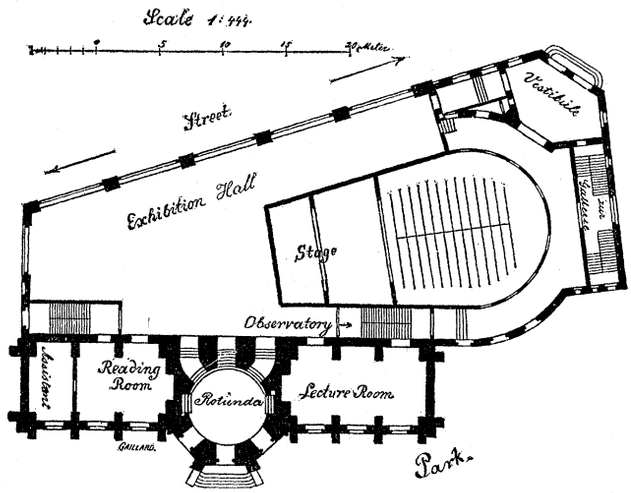
A FEW months ago a company was formed in Berlin, the aims and purposes of which are well worth being widely known. The company is named "Urania," and it was established for the purpose of diffusing the interest in the phenomena of nature. Some of the most prominent German scientists are the promoters of this enterprise, the plan of which originated with the distinguished astronomer Professor W. Foerster, who explains the objects of the company as follows: The object of the society is to promote knowledge. In order to inculcate knowledge, it is necessary to educate man to use his mental powers. Therefore institutions for the diffusion of knowledge can only be successful when they try to teach how to use one's mental powers. The society has limited its work principally to astronomical, geographical, and physical phenomena, and for reaching its object has established a great popular observatory, which will be a model for all similar institutions, and publishes a journal, *Himmel und Erde* (Berlin, H. Paetel), which is beautifully printed and illustrated, and gives, in a popular form, reports on astronomical and geographical phenomena and questions.

The popular observatory, of which we reproduce the plan, is divided into three sections, — the rotunda, which forms the foundation of the observatory proper; the large hall, in which instruments and microscopes are exhibited; and the scientific theatre. It is the plan of the founders of this institute to benefit the general public, which embraces uneducated as well as educated persons. Therefore the methods of instruction are varied according to the intelligence and education of the various classes. The scientific theatre forms the lowest stage, on which the results of exact investigations are presented in as attractive a form as possible, in order to give a stimulus to intelligent observation. Solar and lunar eclipses, comets, and meteors are shown to the spectator; the scenery representing beautiful and characteristic landscapes of the parts of the globe in which these phenomena were seen. Thus the desire is aroused to understand the origin of these phenomena, which, only a few centuries ago, were considered as forebodings of evil. These views are accompanied by lectures calling attention to the peculiarities of the phenomena observed on the scene. Among others, a series of astronomical panoramas has been prepared for the purpose of explaining the phenomena of solar eclipses.

At the commencement of the lecture the stage represents a landscape near Berlin, at the beginning of the total eclipse of Aug. 19, 1887. At that time unfavorable weather prevented the remarkable phenomena from being seen, to which attention had been called in newspapers and journals. In the theatre all phenomena of the eclipse will be shown as they would have happened in clear weather. First the landscape will be seen in the light of the early dawn; then the sun will slowly rise on the horizon in the shape of a crescent between purple clouds. The crescent grows narrower rapidly until the dark shadows of the eclipse appear. After two minutes the character of the illumination changes again, and soon the landscape is seen lighted by the clear sun.

While the lecturer explains this phenomenon, the scene changes, and the spectator is transported to a place at some distance from the earth. The huge globe rotates in front of the zodiac, whose signs form the background. The moon, moving through the sunlight, throws its shadow upon the planet, and it is seen crossing the continent of Europe. It is at once understood how the eclipse originated. We continue our journey and reach the moon. We see its desolate mountain ranges. There is deep night in the valleys, while the summits of the mountains are lighted by the rising sun. On the starry sky the earth is seen, giving some light to the parts of the moon over which the sun has not yet risen. On the earth a small dark dot is seen, the point of the shadow of the moon, and its track shows the region where the eclipse is visible. Our journey is continued toward the sun and the planets, the surfaces of which are shown according to the result of the most recent investigations.

A higher stage of instruction is given in the exhibition hall, in which instruments, apparatus, and arrangements of various kinds,



PLAN OF THE POPULAR OBSERVATORY IN BERLIN.

are exhibited, for the purpose of explaining physical phenomena. The composition of sounds, particularly those of speech, are exhibited. The wonderful phenomena of light; its enormous velocity; its composition of numerous colors, which makes nature appear so beautiful; the wonders of the spectroscope, which betrayed the chemical composition of the celestial bodies, and is at present used in many industries, for instance, in the Bessemer process, and in the examination of wines and other liquids regarding their adulteration; the phenomena of polarization and their application in the manufacture of sugar, — all these will be shown and explained to the visitor. In another section of the hall the phenomena of heat will be explained. Models of machines will be exhibited here in great numbers. In still another part of the hall electricity and magnetism, and their extensive applications in manufactures and as a means of rapid communication between distant places, will be shown. Furthermore, fifty microscopes will be placed in this hall, in which the use of this powerful help to scientific investigation will be explained.

Instruments of precision will be exhibited in the same hall. From the latter a staircase leads to the observatory, passing the lecture-room. Here astronomical and microscopical objects will be shown by means of the lantern, and a lecturer will call attention to the characteristic features of each object before it is seen through the telescopes and microscopes.

The observatory of the Urania will be furnished with a number of small instruments; but, in addition to these, it will have the most powerful telescope of Berlin. The lens of the great refractor will be twelve inches in diameter, while the length of the telescope is to be five metres. The dome is eight metres in diameter.

The establishment of this grand institute marks a new departure in the methods of popularizing the natural sciences, and its influence cannot fail to be wholesome. It will educate the masses to an intelligent observation of natural phenomena.

SCIENTIFIC NEWS IN WASHINGTON.

Irrigation in California. — The Nucleus of a "Zoo." — Mounds of Ohio. — Triple Births in the Human Race. — The Talking-Machine in Use. — Where Will It Go Next?

Irrigation in California.

MR. WILLIAM HAMMOND HALL, State engineer of California, addressed the National Geographic Society on Friday evening last, on irrigation, particularly irrigation operations in California. It appears that the first work of this kind within the State, subsequent to that of the early mission fathers, was undertaken by a band of Mormons in the San Bernardino valley, in 1852.

Of the total area of California perhaps one-third is susceptible of sufficient cultivation to sustain a moderately dense population without the aid of irrigation, while one-third will not sustain a sparse population without the aid of irrigation. The principal regions of irrigation in the State are the great interior valley, the southern valley, and the coast plain of the south. By a comparison of the relative amount of rainfall in the older countries of Europe with that of California, and from the peculiar character of the soil, Mr. Hall showed that the relative necessity for the artificial application of water is far greater in California than in these countries, the annual rainfall being much less, and the character of the soil and rate of evaporation quite as unfavorable.

There are in California about 750,000 to 800,000 acres actually irrigated each year, representing what would ordinarily be called an irrigation area of 1,200,000 acres, and there are reasonably within reach of existing canals 2,500,000 acres. The methods of applying water differ very widely with the differing conditions in the various irrigable areas. Much has been done by individual effort in regions where the problem of diverting water from the streams is comparatively easy; but there remain a large number of streams presenting difficult problems, the waters of which can only be utilized by the expenditure of immense capital and the operation of extensive works. Land values in the valley have increased from $1.25 per acre, prior to the introduction of irrigation, up to $250 and even higher values, merely by having water rights attached. Much is expected from the investigations on this subject which Congress has recently authorized to be prosecuted.

The Nucleus of a "Zoo."

The Department of Living Animals at the National Museum attracts greater crowds of visitors than can find comfortable standing-room in the animal building, and furnishes one of the strongest arguments that could be made on the necessity of a great national zoölogical garden. Gifts and deposits have been coming in in such number, that the museum authorities have found it necessary to decline a number of valuable objects, such as a lioness, aoudad, black leopard, camel, and ostrich, because the institution is positively unable to provide for their accommodation. The total number of live animals, birds, and reptiles received up to date is 281. One of the latest arrivals is a great rarity, a Rocky Mountain sheep from north-western Montana, the gift of Mr. George Bird Grinnell, editor of *Forest and Stream*. It has attracted thousands of visitors, and is at present in fine condition. So far as known, it is the only specimen of the species now alive in captivity.

Mounds of Ohio.

At the instance of Dr. Cyrus Thomas, Mr. Reynolds of the Bureau of Ethnology has recently conducted an exploration of one of the most interesting mounds in Ohio; namely, the truncated pyramid associated with the system of enclosures opposite Bourneville, in the Point Creek valley. These enclosures belong to the type comprising true circles and equilateral squares. It proved to be a burial-mound in which two series of circular upright palings, thirty-six feet in diameter, constituted a pre-eminent feature. These indicated successive erection and use, as the mound was from time to time enlarged. The skeletons found were all interred systematically within these wooden palings upon the different sand-seams at different depths. The burials were evidently successive or periodical. None of them could have been intrusive, since the stratification above them was not disturbed. Many interesting specimens, comprising pottery, stone pipes, shell beads, and grooved bone implements, were found deposited with the various skeletons. These and other features that were observed, will, it is said, prove eminently helpful in the solution of the questions relative to the age and builders of these interesting works.

Triple Births in the Human Race.

Some interesting data respecting the frequency of triplets in the the human race are being collected and elaborated by Dr. B. Ornstein, late surgeon-general of the Greek army. While on an inspection tour through western Greece, he discovered the fact that triplets are more frequently found there than in any other portion of that kingdom. Great difficulty is experienced, however, respecting information as to the age reached by either or all of the children.

It is desirable therefore, for the purpose of careful study of this subject, to gather information based upon the following: viz., (1) all well-authenticated instances of triple births, and in how many of them the three children reached the age of two (or more) years; (2) the number of cases in which two of the triplets survive one year, or longer, or in which one of them reached the age of one year or more.

Any information pertaining to this subject will be gratefully received by Dr. Ornstein, Athens, Greece; or communications will be forwarded if sent to Dr. W. J. Hoffman, Bureau of Ethnology, Washington, D.C.

The Talking-Machine in Use.

The Geological Survey is the first of the government offices to adopt the graphophone for service. Major Powell is supplied with one of these wonderful little listening and talking machines, and he takes it home with him, and talks to it as the necessity arises or an idea strikes him. In his absence an intelligent boy or girl can evoke a repetition of his monologue, and commit it to paper.

Where Will It Go Next?

The apparatus of the Life-Saving Service which has attracted such deep interest in the Cincinnati Exposition is home again, and safely under shelter. Mr. S. I. Kimball, in charge of the bureau, does not wish to return it to the bare and distant loft of the Treasury Department, where for many years it has been an object of curiosity to visitors, but will await the assignment to it of convenient quarters, where the property can be properly protected.

BOOK-REVIEWS.

The Teachers' Psychology. By A. S. WELCH. New York, E. L. Kellogg & Co. 12°. $1.25.

THIS work consists of two distinct parts, the first being a treatise on the intellectual faculties, and the second an essay on the proper method of educating them. The author begins with a general view of the mind as a whole, with its three functions of thought, feeling, and action, but afterwards confines himself to the operations of the intellect. This psychological part of the book cannot be pronounced very successful. Mr. Welch's philosophical standpoint seems to be that of the Scottish school; but he cannot be compared with the standard authors of that school in his method of treatment. He takes a surface view of his subject, and, besides, is often lacking in accuracy. Thus, the term "concept," which has always been used to denote a general idea, is employed in this work for both general and particular ideas. Mr. Welch's view of memory is also peculiar, for he includes in it the act of acquiring knowledge as well as the acts of retaining and recalling it. The second part of the work is of a better character, and lays down

certain principles of education to which little exception can be taken. The author holds that education ought to conform to the course of mental development, each study being introduced at the time when the mind is best fitted to pursue it, and hence that studies requiring a high degree of abstraction and close reasoning should not be taken up until after the simpler and more concrete subjects have been mastered. He gives some examples of wrong arrangement of studies, and some suggestions as to the proper mode of teaching certain branches; and, though there is nothing new in his theories, teachers may find his presentation of them worth examining.

AMONG THE PUBLISHERS.

IN the February *Wide Awake*, "Forty-eight Hours a Day" will interest all astronomically minded young folk, and their elders as well; "An Old-fashioned Boat" is an interesting chapter in the progress of invention, by Ernest Ingersoll; Mrs. Sallie Joy White, in her chapter on "The Use of the Oven," tells how potatoes are baked in the Boston public schools; Mrs. Goddard Orpen gives the history of the famous Spanish crown pearl, the Pelegrina; and Professor Starr, in his geological series, describes some of the gnawings of "The Tooth of Time."

— P. Blakiston, Son, & Co., of Philadelphia, have just ready "A Text-Book of Operative Dentistry," by Professor Thomas Fillebrown of the Harvard Dental School, and a second edition of "A Handbook of Diagnosis and Treatment of Skin Diseases," by Dr. Arthur Van Harlingen. They have nearly ready "A Surgical Handbook," by Professor F. Mitchell Caird and Dr. C. Walker Cathcart, of the University of Edinburgh, thoroughly illustrated, and printed in a convenient shape for carrying about.

— W. H. Lowdermilk & Co. will publish in the course of a week "Matthew's Guide for Settlers upon Public Lands of the United States," intended for all having business before the district land office and the Department of the Interior. It is prefaced by a map of the United States, showing the thirteen original States, with the territory subsequently acquired, giving dates and sources of acquisition and the various State and territorial laws regarding real property, and how under Untited States laws it may be acquired. The author was late assistant chief of the preëmption division, General Land Office.

— G. P. Putnam's Sons announce among their earlier publications for 1889 the following: the first volume of the letter-press edition of "The Writings of Washington," edited by Worthington C. Ford, which will be uniform with the previously published sets of "Hamilton" and "Franklin," and be completed in fourteen volumes, limited to 750 sets; a second edition, revised and enlarged, of "The Best Books: a Reader's Guide to the Choice of the Best Available Books in All Departments of Literature, down to 1888," compiled by William Swan Sonnenschein; and "English Wayfaring Life in the Middle Ages" (fourteenth century), by J. J. Jusserand, translated from the French by Lucy Toulmin Smith. The author has supervised the translation, and has added about a third of new matter, so that the volume differs materially from "La Vie Nomade." The original work was published without illustrations, while this English edition, which is issued in London by T. Fisher Unwin, will be elaborately illustrated from a number of rare designs that have not previously come into publication. Besides these, they announce "A Manual of Oriental Antiquities," including the architecture, sculpture, and industrial arts of Chaldea, Assyria, Persia, Judea, Phœnicia, and Carthage, by Ernest Babelon, librarian of the Department of Medals and Antiquities in the Bibliothèque Nationale of Paris, translated and enlarged by B. T. A. Evetts of the Department of Egyptian and Assyrian Antiquities of the British Museum, with 250 illustrations; "From Japan to Granada: Sketches of Observation and Inquiry in a Tour round the World in 1887–88," by James Henry Chapin, D.D.; "Business," a practical treatise, by James Platt, reprinted, under arrangement with the author, from the 75th English edition; in the Knickerbocker Nuggets, "Ancient Spanish Ballads," historic and romantic, translated, with notes, by J. G. Lockhart, with sixty illustrations by Allan, Roberts, Harvey, and others, and "The Wit and Wisdom of Sydney Smith;" and in the Questions of the Day Series, "Outlines of a New Science, a Study of Industrial Conditions," by E. J. Donnell; "Politics as a Duty and as a Career," by Moorfield Storey; "The Plantation Negro as a Freeman," observations upon his character, conditions, and prospects in Virginia, by Philip A. Bruce.

— D. Lothrop Company will publish shortly a story by a New York lady which is said to be a refutation of much of "Robert Elsmere;" and a volume of stories by H. H. Boyesen, called "Vagabond Tales."

— T. Y. Crowell & Co. have in preparation, for the use of schools, an abridged translation of Duruy's admirable "Histoire de France," under the charge of Professor J. F. Jameson of Brown University. They announce for early publication Bourrienne's "Memoirs of Napoleon Bonaparte" in four volumes. They will be handsomely illustrated, and will contain all the critical and biographical and historical notes which add so much to the value of the latest English edition.

— D. Appleton & Co. announce for this week, "Nature and Man," a series of essays, scientific and philosophical, by the late William Benjamin Carpenter, with an introductory memoir by J. Estlin Carpenter, and a portrait of the writer of the essays. The volume also includes a few passages from Dr. Carpenter's earlier writings, prefixed to illustrate the prior stages of his great labors for physiological psychology.

— Henry Holt & Co. will publish shortly a book on the American Revolution, which will furnish not only novel but highly curious matter. In his researches among the French archives, Mr. John Durand, the translator of M. Taine's "French Revolution," found many documents relating to the United States which were of the greatest interest. These papers have been translated by Mr. Durand for the first time, and are edited by him. The work will throw light on various episodes of the American Revolution as well as on the characters of the men who took part in it. The peculiar *rôle* played by Beaumarchais, the cabal against Washington and Franklin, the secret sessions of the Continental Congress, of which no detailed account has come down to us, together with the social aspects of the country while the Revolution was in progress, will all be presented.

— Harper & Brothers have just published a volume on "The Government of the United States," by W. J. Cocker, A.M., primarily intended as a text-book for public schools, but also calculated to serve as a clear and concise reference manual upon the Constitution. The author presents the influences and conditions which rendered the Constitution a necessity, and describes the powers and limitations of our form of government. The numerous references to more extensive works on the subject make the book a valuable guide in prosecuting further a study of our institutions. Three other books also just ready are: "Modern Science in Bible Lands," by Sir J. W. Dawson, which presents a study of such points of the geology and physical features of Italy, Egypt, and Syria as might throw light on their ancient history, and especially upon the history of the sacred scriptures; "Our English," by Professor Adam S. Hill, which contains novel and sensible suggestions for the proper teaching of the language in schools and colleges, and reviews "Newspaper English," "English in the Novel," "Pulpit English," and "Colloquial English;" also an edition in book form of Charles Reade's "Bible Characters."

— The two latest issues of the *Forum* contain articles by ex-President Andrew D. White of Cornell, on the need of new universities in this country, and particularly on the project for a great central university at Washington. In the January number the writer speaks of the present position of the higher education in America, and of the rapidly increasing demands on the existing universities. He notes the fact that a process of separation is in progress among our institutions of learning, and that a few of them are developing into real universities, while the remainder are tending to become intermediate colleges, holding a position between the universities and the public schools. Real university instruction, he maintains, can only be given in large and liberally endowed institutions, and he believes that we need one or two such institutions of a higher order than any we now have. The most suitable

places for such an institution are New York and Washington. With regard to the former, Columbia College has excellent facilities for supplying the need; but in Mr. White's opinion "the majority of its trustees have long since proved themselves blind to their opportunities." Hence, in a second paper in the February number, he favors the founding of a new university at the national capital, which he thinks the best place in the country for the purpose. The advantages offered by Washington consist partly in the number of able and learned men resident there, whom the university could employ as lecturers or teachers, but still more in the libraries already established in the city, containing over a million volumes, and in the extensive laboratories and other means of investigation maintained by the government. Mr. White believes, that, if the necessary funds could be obtained, a university could be established at Washington which would not only have a powerful influence on the higher education of the country, but would help to raise the tone of political life at the national capital. As to this latter point, however, the question arises whether the politicians would not be more likely to exercise a deleterious influence on the students. Besides this article by Mr. White, the February *Forum* contains ten other papers on a great variety of subjects. Mr. W. F. Lilly has one on "The Foundation of Ethics," in which he takes strong ground against the evolutionary theory of ethics as taught by Herbert Spencer, maintaining that it is not only false, but practically pernicious, and that it is already exercising a baneful influence on moral conduct in art, journalism, politics, and other departments of action. What its effects and tendencies are, he promises to state more fully in succeeding articles. Judge Alfred C. Coxe has an important paper on "Relief for the Supreme Court." He alludes to the fact that the Supreme Court of the United States is three or four years behind its docket, and then suggests that the court might catch up with its work if the judges were relieved from circuit duty, which would enable them to sit at Washington two months longer than they do now, and if the practice of reading opinions, which now occupies one day in each week, was abandoned. The other articles we have not space to notice. The *Forum* has taken its place as the foremost magazine for general discussion in the country; but it seems to us, that, if some of the papers it prints were longer and more elaborate, its usefulness would be enhanced.

LETTERS TO THE EDITOR.

***Correspondents are requested to be as brief as possible. The writer's name is in all cases required as proof of good faith.*

Twenty copies of the number containing his communication will be furnished free to any correspondent on request.

The Baconian Method in Science.

IN the nineteenth aphorism of his "Novum Organum," which forms the second part of his "Instauratio Magno," Lord Bacon observes that there are two possible methods for investigating and discovering truth. The one, he says, flies at once from particular observations to axioms of the broadest generality, and from these principles and their immutable verity it scrutinizes and discovers its mediatory axioms or propositions leading to subordinate truths. The other method from particular observations calls forth axioms in a continuous and gradual ascent, so as at last to attain truths of the broadest generality. The former of these methods, he says, is the one in use; the other is new and untried.

The former method is familiarly known as the deductive method. This movement of thought was thoroughly studied and expounded by Aristotle, and is well understood. Lord Bacon opposed his "new and untried" method to the old in this specific feature, that the old or deductive method moved characteristically from the general to the more specific, whereas his new method proceeded from the particular, and advanced, step by step, to the general. Obviously this new movement of his is simply what is known in recent logical science as generalization, — the amplification of a subject-notion or concept. It does not appear from Lord Bacon's writings that he concerned himself at all about the special differences between logical generalization and logical induction. He only insisted that scientific study should in the future unite the two methods, — the old, which moved from the general to the particular, with the new, which moves from the particular to the general. Nor does he appear ever to distinguish the movement of thought in proper generalization, which confines itself to the subject-notion, from that known in logic as determination, which is the amplification of the attribute-notion; just as the old method did not distinguish between the two movements in the reduction of a concept or notion, — between division, which was applied to subject-notions, and partition, which was applied to attribute-notions.

These movements of thought are fundamental movements, and differ widely from one another in their respective natures and their governing laws. It is as important for the facile and successful prosecution of scientific study in any field of knowledge that they be familiarly known, and be reduced to ready use, as it is for the successful prosecution of mathematical studies that the fundamental or ground rules of arithmetic be mastered for accurate, and, as it were, instinctive application whenever needful. Popular discourse may, perhaps, be pardoned for some looseness in the use of the technical terms and phrases of science; but discussion professedly scientific, and claiming for itself something of the certitude of genuine knowledge, should not ignore these ground rules of scientific knowledge, nor confound them one with another. Widely as they differ, they are alike serviceable for scientific uses; they are of equal valitlity; they are equally intelligible in their essential nature and in their applications. This is evident from the most cursory exposition.

All complete thought is quantitative. This attribute is revealed among the most fundamental properties of thought. But in quantity, which is but the attribute otherwise known as that of "whole and parts," as we conceive of an object quantitatively when we conceive of it as a whole having parts, extensive or intensive — in quantity there are three, and only three, conceivable relationships of the highest or most generic order; viz., (1) that of whole to part, (2) that of part to whole, and (3) that of part to part. There are, accordingly, only three corresponding movements of thought possible in this relationship: (1) deduction, (2) generalization, and (3) induction. We pass over here the distinctions already indicated as required in accurate science to be made on account of the diverse charcter of notions as subject-notions or as attribute-notions, and use the familiar designations of the different movements. Deduction moves from whole to part; generalization, from part to whole; induction, from part to part.

Notwithstanding this manifest, and to a large extent familiarly recognized, distinction between these fundamental movements of thought, there is a common loose or faulty use of the terms which properly designate them that is greatly to be deprecated. Particularly is this observable in the case of the term "induction" and its paronymes. For example: "an inductive study of the mind" or "of the Scriptures" is every now and then proposed, when a true inductive study obviously could never have been intended. And even among professedly scientific thinkers are to be detected not infrequently the most shadowy and illusive or even positively false notions of induction and inductive science. Modern science boasts of itself as being characteristically and distinctively inductive, while it would be difficult to find in its work any conscious recognition of the essential character of this fundamental movement of thought. In truth, even logical science has but very imperfectly apprehended it, although the most familiar movement in every-day life. The child induces from one experience from touching the flame what a repetition will cause, and confidently expects to find in the next flower he plucks something of the figure or color or fragrance that he has found in the one he has already gathered. Moreover, the exact character of the movement was scientifically grasped and indicated many centuries ago by the father of logical science. He did not elaborate the exposition of the inductive movement as he did that of the deductive movement; but he exemplified it perfectly in the first book of his "Prior Analytics," c. xxv. (Tauchnitz edition), where from "bileless" and "long-lived" being both attributes of "man," "horse," etc., he infers that the presence of "bileless" involves that of "long-lived." The principle, he says, is this: if any two attributes as parts belong to the same whole, the existence of either one in any case determines the existence of the other. We might state it thus: from any part of a given whole we may infer or induce any complementary part.

LOGICUS.